Site Investigation Report
Tanks 38, 42, 45, and 48
Tank Farm 4

Volume I - Text, Tables, and Figures

Naval Education and Training Center
Newport, Rhode Island

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0143

April 1996

Brown & Root Environmental

A Division of Halliburton NUS Corporation

W5296104F

SITE INVESTIGATION REPORT
TANKS 38, 42, 45, AND 48
TANK FARM 4

VOLUME I - TEXT, TABLES, AND FIGURES

NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 1812PFB
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop No. 2
Lester, Pennsylvania 19113-2090

Submitted by:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087

CONTRACT NUMBER N62472-90-D-1298
"CLEAN" Contract Task Order No. 0143

April 1996

PREPARED BY:

WALTER J. MARTIN
PROJECT MANAGER
BROWN & ROOT ENVIRONMENTAL
WILMINGTON, MASSACHUSETTS

APPROVED BY:

John J. Trepanowski
JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
BROWN & ROOT ENVIRONMENTAL
WAYNE, PENNSYLANIA

STATEMENT OF ACCURACY

As required by the Rhode Island Department of Environmental Management Regulations for Underground Storage Facilities used for Petroleum Products and Hazardous Materials (DEM DWM-UST05-93) Section 14.12 (B) (1), effective December 30, 1993, the undersigned certifies that information presented in this Site Investigation Report for Tank 38 (FACID-3644TNO-38), Tank 42 (FACID-3644TNO-42), Tank 45 (FACID-3644TNO-45), and Tank 48 (FACID-3644TNO-48), Tank Farm 4, at the Naval Education and Training Center in Newport, Rhode Island, is accurate to the degree specified in this report and the Final Work Plan for Preliminary Closure Assessments (HNUS 4/94) and Amendment (HNUS 3/95).

James R. Forrelli

James R. Forrelli, P.E.
Brown & Root Environmental

As required by the Rhode Island Department of Environmental Management Regulations for Underground Storage Facilities used for Petroleum Products and Hazardous Materials (DEM DWM-UST05-93) Section 14.12 (B) (2), effective December 30, 1993, the undersigned (facility owner/operator representative) certifies that information presented in this Site Investigation Report for Tank 38 (FACID-3644TNO-38), Tank 42 (FACID-3644TNO-42), Tank 45 (FACID-3644TNO-45), and Tank 48 (FACID-3644TNO-48), Tank Farm 4,at the Naval Education and Training Center in Newport, Rhode Island, is complete and accurate to the degree specified in this report and the Final Work Plan for Prelimnary Closure Assessments (HNUS, 9/94), and Addendum (HNUS 3/95).

Brian J. Helland

Brian J. Helland
Remedial Project Manager
Naval Facilities Engineering Command

TABLE OF CONTENTS
VOLUME I - TEXT, TABLES, AND FIGURES

SECTION			PAGE
E.0	EXECUTIVE SUMMARY		ES-1
1.0	INTRODUCTION		1-1
	1.1	AUTHORIZATION	1-1
	1.2	OBJECTIVES AND SCOPE	1-1
	1.3	REPORT ORGANIZATION	1-2
2.0	BACKGROUND		2-1
	2.1	LOCATION	2-1
	2.2	SITE HISTORY	2-1
	2.3	PREVIOUS INVESTIGATIONS AND REGULATORY HISTORY	2-5
	2.3.1	Regulatory Requirements	2-5
	2.3.2	Summary of Previous Investigations and Regulatory History	2-5
	2.4	NATURE OF HISTORICAL RELEASES	2-8
	2.5	SITE DESCRIPTION	2-9
	2.5.1	Site Features	2-9
	2.5.2	Buildings	2-9
	2.5.3	Topography	2-9
	2.5.4	Surface Water and Wetlands	2-11
	2.5.5	Vegetation	2-11
	2.5.6	Water Supply Wells	2-11
	2.5.7	Public Sewer and Water Lines	2-11
	2.5.8	Waste Disposal Systems	2-11
	2.5.9	Locations of USTs and Piping	2-12
	2.5.10	Locations of Soil Borings and Monitoring Wells	2-12
	2.6	SUMMARY OF THE TANK FARM FACILITY	2-12
	2.6.1	Tank Construction	2-12
	2.6.2	Shunt/Loop Piping Construction	2-20
	2.7	UNDERGROUND UTILITIES	2-20
	2.8	CLOSURE ACTIVITIES	2-21
	2.8.1	Tank Gauging and Sampling	2-21
	2.8.2	Tank Condition	2-21
3.0	GEOLOGY, HYDROGEOLOGY, AND WATER RESOURCES		3-1
	3.1	REGIONAL GEOLOGY	3-1
	3.1.1	Regional Bedrock Geology	3-1
	3.1.2	Regional Surficial Geology	3-2
	3.2	SITE GEOLOGY - SOIL AND BEDROCK CONDITIONS AT TANK FARM 4	3-2
	3.2.1	Surficial Deposits	3-2
	3.2.2	Bedrock	3-4
	3.3	HYDROGEOLOGY	3-4
	3.3.1	Interpretive Water Table Map	3-4
	3.3.2	Hydraulic Conductivity Measurements	3-6
	3.3.3	Vertical Hydraulic Gradients	3-9
	3.3.4	Horizontal Hydraulic Gradients	3-9
	3.3.5	Saturated Thickness	3-9
	3.3.6	Barriers to Contaminant Migration	3-9

TABLE OF CONTENTS (Continued)
VOLUME I - TEXT, TABLES, AND FIGURES

SECTION **PAGE**

3.4 GROUNDWATER RESOURCES AND POTENTIAL RECEPTORS 3-10
3.4.1 Site Wellhead Protection Status 3-10
3.4.2 Site Groundwater Classification 3-10
3.4.3 Potential Receptors 3-10

4.0 TANK 38 SITE INVESTIGATION 4-1
4.1 ANALYTICAL METHODS 4-5
4.1.1 Field Screening 4-5
4.1.2 Laboratory Analysis 4-6
4.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT 4-7
4.2.1 Analytical Data Summary 4-7
4.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION 4-13
4.3.1 Subsurface Soils 4-13
4.3.2 Groundwater 4-17
4.3.3 Hydraulic Conductivity Measurements 4-17
4.3.4 Saturated Thickness 4-18
4.3.5 Surface Soil 4-18
4.4 VOLATILE ORGANIC COMPOUND MONITORING 4-18
4.5 SURFACE WATER DRAINAGE 4-20
4.6 COMPARISONS TO REGULATORY STANDARDS 4-20
4.6.1 TPH Clean-up Levels 4-21
4.7 FUTURE ACTIONS 4-23
4.7.1 Source Control 4-23
4.7.2 Institutional Controls 4-23

5.0 TANK 42 SITE INVESTIGATION 5-1
5.1 ANALYTICAL METHODS 5-3
5.1.1 Field Screening 5-5
5.1.2 Laboratory Analysis 5-5
5.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT 5-6
5.2.1 Analytical Data Summary 5-7
5.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION 5-12
5.3.1 Subsurface Soils 5-12
5.3.2 Groundwater 5-16
5.3.3 Hydraulic Conductivity Measurements 5-16
5.3.4 Saturated Thickness 5-17
5.3.5 Surface Soil 5-17
5.4 VOLATILE ORGANIC COMPOUND MONITORING 5-17
5.5 SURFACE WATER DRAINAGE 5-20
5.6 COMPARISONS TO REGULATORY STANDARDS 5-20
5.6.1 TPH Clean-up Levels 5-22
5.7 FUTURE ACTIONS 5-24
5.7.1 Source Control 5-24
5.7.2 Interim Action 5-25

TABLE OF CONTENTS (Continued)
VOLUME I - TEXT, TABLES, AND FIGURES

SECTION			PAGE
6.0	TANK 45 SITE INVESTIGATION		6-1
	6.1	ANALYTICAL METHODS	6-6
	6.1.1	Field Screening	6-6
	6.1.2	Laboratory Analysis	6-7
	6.2	FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT	6-8
	6.2.1	Analytical Data Summary	6-8
	6.3	FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION	6-16
	6.3.1	Subsurface Soils	6-21
	6.3.2	Groundwater	6-23
	6.3.3	Hydraulic Conductivity Measurements	6-23
	6.3.4	Saturated Thickness	6-24
	6.3.5	Surface Soil	6-24
	6.4	VOLATILE ORGANIC COMPOUND MONITORING	6-26
	6.5	SURFACE WATER DRAINAGE	6-26
	6.6	COMPARISONS TO REGULATORY STANDARDS	6-26
	6.6.1	TPH Clean-up Levels	6-27
	6.7	FUTURE ACTIONS	6-30
	6.7.1	Source Control	6-30
	6.7.2	Interim Action	6-30
7.0	TANK 48 SITE INVESTIGATION		7-1
	7.1	ANALYTICAL METHODS	7-6
	7.1.1	Field Screening	7-6
	7.1.2	Laboratory Analysis	7-7
	7.2	FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT	7-8
	7.2.1	Analytical Data Summary	7-9
	7.3	FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION	7-16
	7.3.1	Subsurface Soils	7-16
	7.3.2	Bedrock	7-28
	7.3.3	Groundwater	7-29
	7.3.4	Hydraulic Conductivity Measurements	7-29
	7.3.5	Saturated Thickness	7-30
	7.3.6	Surface Soil	7-30
	7.4	VOLATILE ORGANIC COMPOUND MONITORING	7-32
	7.5	SURFACE WATER AND SEDIMENT SAMPLING	7-32
	7.6	COMPARISONS TO REGULATORY STANDARDS	7-32
	7.6.1	TPH Clean-up Levels	7-34
	7.6	FUTURE ACTIONS	7-36
	7.6.1	Source Control	7-36
	7.6.2	Interim Action	7-36

TABLE OF CONTENTS (Continued)
VOLUME I - TEXT, TABLES, AND FIGURES

SECTION		PAGE
8.0	**SUMMARY AND CONCLUSIONS**	**8-1**
8.1	GENERAL	8-1
8.2	TANK 38	8-1
8.3	TANK 42	8-2
8.4	TANK 45	8-3
8.5	TANK 48	8-4
8.6	GROUNDWATER	8-5
8.7	VOC MONITORING	8-6
8.8	WELLHEAD PROTECTION INFORMATION	8-6
8.0	POTENTIAL RECEPTORS	8-6
9.0	**RECOMMENDATIONS**	**9-1**
9.1	TANKS 42, 45, AND 48	9-1
9.1.1	Source Control	9-1
9.1.2	Interim Action	9-1
9.2	TANK 38	9-2
9.2.1	Source Control	9-2
9.2.2	Development of Remedial Alternatives	9-2
9.2.3	Additional Investigation	9-3
9.2.4	Preparation of the Corrective Action Plan	9-3
REFERENCES		

TABLES

NUMBER		PAGE
2-1	Summary of Investigations	2-6
2-2	Ground Elevation in the Vicinity of the Tanks	2-10
2-3	Summary of Volumes of Tank Contents	2-22
3-1	Hydraulic Conductivity Results	3-7
4-1	Summary of Surface Soil Samples, Soil Borings, and Monitoring Wells, Tank 38	4-4
4-2	Positive Organic and Inorganic Analytes Detected in Soil and Groundwater, Tank 38	4-9
4-3	TPH in Subsurface Soil, Tank 38	4-12
4-4	TPH in Groundwater, Tank 38	4-14
4-5	Summary of Engineering Parameters - Positive Detects in Subsurface Soil Samples, Tank 38	4-15
4-6	TPH in Surface Soil, Tank 38	4-19
5-1	Summary of Surface Soil Samples, Soil Borings, and Monitoring Wells, Tank 42	5-4
5-2	Positive Organic and Inorganic Analytes Detected in Soil and Groundwater, Tank 42	5-8
5-3	TPH in Subsurface Soil, Tank 42	5-13
5-4	TPH in Groundwater, Tank 42	5-14
5-5	Summary of Engineering Parameters - Positive Detects in Subsurface Soil Samples, Tank 42	5-15
5-6	TPH in Surface Soil, Tank 42	5-19

TABLE OF CONTENTS (Continued)
VOLUME I - TEXT, TABLES, AND FIGURES

TABLES (Continued)

NUMBER		PAGE
6-1	Summary of Surface Soil Samples, Soil Borings, and Monitoring Wells, Tank 45	6-3
6-2	Positive Organic and Inorganic Analytes Detected in Soil and Groundwater, Tank 45	6-11
6-3	TPH in Subsurface Soil, Tank 45	6-17
6-4	TPH in Groundwater, Tank 45	6-19
6-5	Summary of Engineering Parameters - Positive Detects in Subsurface Soil Samples, Tank 45	6-20
6-6	TPH in Surface Soil, Tank 45	6-25
7-1	Summary of Surface Soil Samples, Soil Borings, and Monitoring Wells, Tank 48	7-3
7-2	Positive Organic and Inorganic Analytes Detected in Soil and Groundwater, Tank 48	7-10
7-3	TPH in Subsurface Soil, Tank 48	7-17
7-4	TPH in Groundwater, Tank 48	7-19
7-5	Summary of Engineering Parameters - Positive Detects in Subsurface Soil Samples, Tank 48	7-20
7-6	TPH in Surface Soil, Tank 48	7-31

FIGURES

NUMBER		PAGE
2-1	Location Map	2-2
2-2	Tank Farm 4 Location	2-3
2-3	Location Map - Tank Farm 4	2-4
2-4	Boring and Sampling Locations - Tank 38	2-13
2-5	Boring and Sampling Locations - Tank 42	2-14
2-6	Boring and Sampling Locations - Tank 45	2-15
2-7	Boring and Sampling Locations - Tank 48	2-16
2-8	Typical Tank Cross Section	2-17
3-1	Interpreted Water Table Map	3-5
4-1	Cross-Section Locus Map - Tank 38	4-2
4-2	Cross-Section A-A' - Tank 38	4-16
5-1	Cross-Section Locus Map - Tank 42	5-2
5-2	Cross-Section A-A'- Tank 42	5-18
6-1	Cross-Section Locus Plan - Tank 45	6-5
6-2	Cross-Section A-A' - Tank 45	6-9
6-3	Cross-Section B-B' - Tank 45	6-22
7-1	Cross-Section Locus Plan - Tank 48	7-5
7-2	Cross-Section A-A' - Tank 48 - TPH in Soil	7-22
7-3	Cross-Section B-B' - Tank 48 - TPH in Soil	7-23
7-4	Cross-Section C-C' - Tank 48 - TPH in Soil	7-24
7-5	Cross-Section A-A' - Tank 48 - TPH in Groundwater	7-25
7-6	Cross-Section B-B' - Tank 48 - TPH in Groundwater	7-26
7-7	Cross-Section C-C' - Tank 48 - TPH in Groundwater	7-27

TABLE OF CONTENTS (C ntinued)

VOLUME II - APPENDICES

APPENDICES

A	FLOOR PLAN, TANK 42
B	SOIL BORING AND SOIL PROBING LOGS
C	WELL CONSTRUCTION LOGS
D	ANALYTICAL DATA
E	RELEVANT SECTIONS OF THE MASSACHUSETTS CONTINGENCY PLAN
F	HYDRAULIC CONDUCTIVITY DATA

E.0 EXECUTIVE SUMMARY

Brown & Root Environmental (B&R Environmental) conducted Preliminary Closure Assessments (PCAs) of 12 underground storage tanks (USTs) at Tank Farm 4, located at the Naval Education and Training Center - Newport, Rhode Island. The assessments indicated releases of petroleum may have occurred at five of the tanks, numbers 38, 40, 42, 45 and 48, and led to conducting site investigations (SIs) at four of the tanks, numbers 38, 42, 45, and 48. Only low concentrations of petroleum were detected in soils at Tank 40 (140 milligrams per kilogram [mg/kg]), and a SI was not conducted. This report presents the results of SIs conducted at Tanks 38, 42, 45, and 48.

Tank Farm 4 was constructed as a war measure from 1942 to 1943 on property owned by the Navy to support the fueling requirements of the Newport-based Atlantic Fleet. The tank farm consists of twelve 2.52-million-gallon concrete USTS, constructed in "sockets" excavated into bedrock. The tanks were used to store heavy fuel oils and No. 2 fuel oil, from World War II until 1974. For a brief period in the mid-1970s, three or four tanks were leased to a private petroleum distribution company and used to store No. 2 fuel oil. By 1977 all tanks were taken out of service.

As a result of amendments to State of Rhode Island regulations promulgated in 1993 concerning the management of underground petroleum storage facilities, tanks used to store fuel oils became subject to state UST closure requirements. On February 18, 1994, the Navy filed an application with the Rhode Island Department of Environmental Management (RIDEM) to permanently close the tanks at Tank Farm 4. Pipe decommissioning, tank cleaning, and tank ballasting at Tank 42 was initiated in December 1995 by OHM Remediation Services, Inc. (OHM). The tank was inspected and approved by RIDEM for closure. Closure of the other tank farm facilities, including Tanks 38, 45, and 48, is scheduled to be completed during the summer of 1996.

As part of tank closure, an inspection of the tank interior is routinely conducted to assess structural integrity. Various randomly oriented cracks on the tank floors are typically identified. The possibility that an unknown quantity of petroleum was released through the network of minor cracks may explain the presence of petroleum-impacted soils in tank sockets. Repairs are recommended based on the severity of cracking. Only minor cracking was observed in Tank 42, and no recommendations for repair were made. Inlets and outlets to the tank have been capped, and the tank has been ballasted with clean water.

RIDEM generally establishes UST-related soil and groundwater clean-up criteria on a case-by-case basis considering potential off-site migration of impacted groundwater, and the presence of site-specific potential human and ecological receptors.

Considering the lack of receptors and site-specific characteristics, concentrations in soil of 2,500 mg/kg and 5,000 mg/kg total petroleum hydrocarbon (TPH) will be proposed by the Navy as clean-up levels as indicated in the following paragraphs. These concentrations are considered conservative and were adopted as risk-based soil clean-up standards by Massachusetts and published as part of the Massachusetts Contingency Plan (MCP) in November, 1993. The standards are not legally binding in Rhode Island.

The proposed clean-up level of 2,500 mg/kg TPH in soil considers that soils may be located within a water supply well zone of contribution and are "potentially accessible," which means being located at a depth of 3 to 15 feet below the ground surface.

The proposed clean-up level of 5,000 mg/kg TPH in soil considers that soils may also be located within a water supply well zone of contribution and are isolated, which means being located at a depth greater than 15 feet below the ground surface.

Ingestion of groundwater is not considered a potential exposure pathway.

Tank 38

Petroleum-impacted subsurface soils were identified within the tank socket, at depths of 32 feet below the ground surface, to the top of bedrock, which is located 40 feet below ground surface. Non-aqueous phase liquids (NAPL) were noted throughout the zone of impacted soils typically saturating coarse-grained fill materials. Soils exceeding the proposed clean-up level concentration w re not identified at Tank 38. The highest concentration of TPH detected in soils was 2,100 mg/kg.

Fill materials in the tank sockets were described as non-homogeneous mixes of coarse- and fine-grained soils. Coarse-grained soils located below the water table tended to be saturated with NAPL, while fine-grained soils were visually not impacted. Soil samples were collected from two-foot intervals and tend to average TPH concentrations within the sampled interval. This practice results in a lower than expected TPH concentration, however, more accurately represents TPH concentrations present throughout the fill.

Results indicate that the fill materials in the lower portion of the tank socket are impacted by petroleum, and that NAPL is present throughout coarse-grained fill materials at this location.

A soil boring advanced approximately 25 feet downgradient of Tank 38, outside of the tank socket, did not encounter petroleum-impacted soils.

Groundwater samples collected from three groundwater monitoring wells screened within petroleum-impacted soils contained a maximum TPH concentration of 24 milligrams per liter (mg/L). Immiscible oil droplets and NAPL were noted in well development water from these wells.

No soil samples exceeded the TPH-in-soil clean-up levels proposed by the Navy.

Tank 42

Petroleum-impacted subsurface soils were identified within the tank socket, at depths of 32 feet below the ground surface, to the top of bedrock, which is located approximately 40 feet below ground surface. NAPL was noted throughout the zone of impacted soils, typically saturating coarse-grained fill materials. One soil sample collected from the ring drain contained TPH at a concentration of 5,700 mg/kg, exceeding the clean-up level proposed by the Navy.

Results indicate that the fill materials in the lower portion of the tank socket are impacted by petroleum, and that NAPL is present throughout coarse-grained fill materials at this location.

A soil boring advanced approximately 27 feet downgradient of Tank 42, outside of the tank socket, did not encounter petroleum-impacted soils.

Three groundwater samples were collected and analyzed for TPH at Tank 42 within zones of impacted soils. The highest concentration of TPH in groundwater at Tank 42 was detected at the downgradient side of the tank at a concentration of 10 mg/L.

Immiscible oil droplets and NAPL were noted in well development water from two of these wells.

One soil sample exceeded the TPH-in-soil clean-up criteria proposed by the Navy.

Tank 45

Petroleum-impacted subsurface soils were identified within the tank socket, at depths of 30 feet below the ground surface, to the top of bedrock, located approximately 40 feet below ground surface. NAPL was noted throughout the zone of impacted soils, typically saturating coarse-grained fill materials. Three soil samples contained TPH at a concentration of 7,100, 11,000, and 23,000 mg/kg, exceeding the TPH clean-up levels proposed by the Navy.

Results indicate that the fill materials in the lower portion of the tank socket are impacted by petroleum, and that NAPL is present throughout coarse-grained fill materials at this location.

Two soil borings advanced approximately 25 feet downgradient of Tank 45, outside of the tank socket, did not encounter petroleum-impacted soils.

Groundwater samples collected from two groundwater monitoring wells screened within petroleum-impacted soils contained a maximum TPH concentration of 9.3 mg/L.

Immiscible oil droplets and NAPL were noted in well development water.

Tank 48

Results indicate that the fill materials throughout the tank socket are impacted by petroleum, and that NAPL is present throughout coarse-grained fill materials at this location. The maximum TPH concentration at Tank 48 was 5,300 mg/kg, which exceeds the proposed clean-up level concentration. Petroleum migrated approximately 50 feet downgradient of the tank in the overburden and was detected in one boring at that location. Five other soil borings advanced from approximately 30 feet cross-gradient to the tank to 70 feet downgradient of Tank 48, outside of the tank socket, did not encounter petroleum-impacted soils.

Groundwater samples collected from six monitoring wells screened within petroleum-impacted soils contained a maximum TPH concentration of 87 mg/L. The maximum TPH concentration in groundwater at Tank 48 was 440 mg/L in bedrock well MW-424. NAPL was present in well development water and groundwater samples collected from overburden and bedrock wells.

Groundwater

The presence of only low concentrations of TPH in groundwater samples, collected from monitoring wells installed in fill materials downgradient of the tank sockets, indicates that the unconsolidated overburden aquifer is not a significant migration pathway for heavy fuel oil compounds released from the tanks.

The fill material within the sockets has a significantly higher hydraulic conductivity than the surrounding bedrock, thus a higher permeability than the surrounding materials (B&R Environmental, 1995b). The surrounding bedrock may act to limit the horizontal migration of free-phase petroleum and petroleum-impacted groundwater in the unconsolidated aquifer.

Impacted groundwater is present in the bedrock aquifer at Tank 48, however. TPH is present at a concentration of 440 mg/L, and is associated with the occurrence of NAPL contained within bedrock fractures. The extent of impacted groundwater at this location has not been determined.

VOC Monitoring

Air monitoring and soil screening with a photoionization detector (PID) was conducted at each tank during the site investigations. No VOCs were detected in the ambient air or in surficial soils at any of the tanks.

Receptors

The tanks are not located within a designated wellhead protection area. The groundwater beneath the tanks is classified by RIDEM as "GB". Groundwater classified as GB is not suitable for public or private drinking water use.

No private or public potable water supply wells are located on, or downgradient from, the tanks. No known private wells or basements exist that could potentially be affected by the petroleum releases.

Proposed Future Actions: Tank 38

Several options are available to address petroleum-impacted soil at Tank 38; however, because soil TPH concentrations do not exceed the proposed risk-based clean-up levels, the most appropriate general response action may be source control (removal of tank contents is scheduled for the summer of 1996), followed by implementation of institutional controls.

Institutional controls include options such as deed restrictions, access restrictions, posting signs, and monitoring. Deed restrictions, land use restrictions, or other policies or rules can prevent the exposure of workers and nearby residents to the subsurface contaminants. These controls are intended to limit future placement of drinking water wells, construction or demolition activities, and excavation within the areas of the tanks.

Institutional controls or deed restrictions are also intended to prohibit excavation in the vicinity of the tank without proper engineering controls in order to protect site workers. Engineering controls include fugitive dust emissions management, and other site safety precautions such as implementing a health and safety plan, and using personal protection equipment (PPE).

While no engineered treatment process is proposed, natural attenuation may result in reduction of the petroleum concentrations detected in the environment. Naturally occurring chemical, physical, and biochemical processes such as dilution, biodegradation, adsorption, and chemical reactions within subsurface materials could also reduce TPH concentrations over time.

Proposed Future Actions: Tanks 42, 45, and 48

Tank 42 was cleaned in December 1995. Tank 45 and 48 tank contents removal and cleaning is scheduled for the summer of 1996. The tanks will be inspected and closed following approval by RIDEM.

Groundwater levels are lowered to the elevation of the tank floor during tank closure operations. The ring drain system is used to manage the groundwater level at the tanks for the duration of closure activities, a period of approximately one to two months. During the pumping of ring drains for tank closure activities at Tank Farm 5, an undetermined quantity of petroleum was removed from fill materials within the socket and treated in the on-site water treatment facility. Although data is not available to quantify the removal of petroleum mass from the fill materials, TPH concentrations detected in samples collected during the SI (conducted after ring drain pumping) were consistently lower than TPH concentrations in samples collected during the PCA (conducted prior to ring drain pumping). The pumping action may have resulted in the removal of enough contaminant mass from the fill materials surrounding each tank to lower petroleum concentrations at the sites.

Following the contents removal and cleaning, additional groundwater and subsurface soil samples will be collected from zones of petroleum-impacted soil which was determined during the SI to exceed proposed clean-up standards. These samples will be analyzed and results will be used to evaluate effects of groundwater pumping on TPH concentrations in soil and groundwater.

The results of the contents removal and cleaning will determine the need for additional remedial action. Selection of a remedial action will be evaluated contingent upon the results of the bioremediation pilot study planned for Tank 50, Tank Farm 5. Results are expected to be available in the fall of 1996.

1.0 INTRODUCTION

1.1 AUTHORIZATION

This report presents the results of Site Investigations (SIs) conducted at four underground storage tanks (USTs), Tank 38 (FACID-3644 TNO38), 42 (FACID-3644 TNO42), 45 (FACID-3644 TNO45), and 48 (FACID-3644 TNO48) hereby referred to as "the Tanks", located in Tank Farm 4 at the Naval Education and Training Center (NETC) Newport, Rhode Island. Tank Farm 4 is located at the northern portion of NETC-Newport, in Portsmouth, Rhode Island. The SIs were conducted following the discovery of petroleum-stained soils and elevated concentrations of total petroleum hydrocarbons (TPH) in soils at the Tanks during the Preliminary Closure Assessments (PCAs) performed in October 1994. The SI field work was conducted from November 1995 to January 1996. Results of the PCA field investigations are incorporated into this report.

This report was prepared by Brown & Root Environmental (B&R Environmental), a division of Halliburton NUS Corporation (HNUS) at the request of the United States Navy, Northern Division (NORTHDIV) of the Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) Number 143 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298.

The investigation was conducted in accordance with the requirements of Rhode Island Department of Environmental Management (RIDEM) Regulation DEM-DWM-UST05-93 Section 14.08, the Final Work Plan and Amendments, and related Cost Impact Letters dated November 14, 1994 and December 27, 1994. This report was prepared in accordance with Section 14.09 of RIDEM regulation DEM-DWM-UST05-93, as detailed by the December 1993 RIDEM guidance document entitled: "Regulations For Underground Storage Tank Facilities Used For Petroleum Products And Hazardous Materials" (RIDEM, 1993a).

1.2 OBJECTIVES AND SCOPE

The objectives of the SIs are: to delineate the nature and extent of petroleum-impacted soils and groundwater at each tank; to gather information to determine the need for and extent of remedial action; to identify threats to public health and the environment; and to provide data to develop response objectives. The information gathered during the SIs will also provide supportive documentation that may be required to prepare Corrective Action Plans in accordance with RIDEM regulations.

The scope of work for the SIs included: collecting surficial soil samples for laboratory analyses; advancing borings in overburden; collecting subsurface soil samples to provide analytical data and soil engineering characteristics; installing overburden groundwater monitoring wells; installing bedrock monitoring wells, where appropriate; analyzing groundwater samples; and performing a survey to provide horizontal and vertical control of features pertinent to the investigation.

1.3 REPORT ORGANIZATION

Sections 1.0 through 3.0 of this report contain information and data which are common to each of the four tanks. Sections 4.0 through 7.0 describe activities and data specific to SIs conducted at each tank.

This SI report is organized as follows:

- Section 1.0, Introduction, presents the authorization for the SIs, and outlines their objectives and scope.

- Section 2.0, Background, provides a summary of the facility background and history; describes previous investigations and regulatory history; discusses the nature of possible historical releases; presents a description of site features and physiography; reviews tank construction activities; and summarizes general tank closure activities conducted at Tank Farm 4.

- Section 3.0, Geology, Hydrogeology,and Water Resources, presents the regional and site-specific geology, hydrogeology, and groundwater resources, and identifies the absence of potential receptors of releases from the tank farms.

- Section 4.0, Tank 38 Site Investigation, summarizes B&R Environmental's field investigations and activities conducted at Tank 38 to evaluate the presence of petroleum-impacted soils and groundwater in the vicinity of the tank. Findings of field investigations at Tank 38 presents analytical methods and results of investigation activities, and discusses the nature and extent of petroleum-impacted media in the immediate vicinity of the tank.

- Section 5.0, Tank 42 Site Investigation, summarizes B&R Environmental's field investigations and activities conducted at Tank 42.

- Section 6.0, Tank 45 Site Investigation, summarizes B&R Environmental's field investigations and activities conducted at Tank 45.

- Section 7.0, Tank 48 Site Investigation, summarizes B&R Environmental's field investigations and activities conducted at Tank 48.

- Section 8.0, Summary and Conclusions, summarizes site investigation findings, and presents conclusions pertaining to results of site investigation activities.

- Section 9.0, Recommendations, identifies the recommended remedial alternative and actions to be taken based on the results of the site investigations.

2.0 BACKGROUND

This section presents background information concerning the location and description of the tanks, a summary of the site and operational history of Tank Farm 4, and a summary of previous investigations. Pertinent construction details concerning the tanks and associated piping are also presented.

2.1 LOCATION

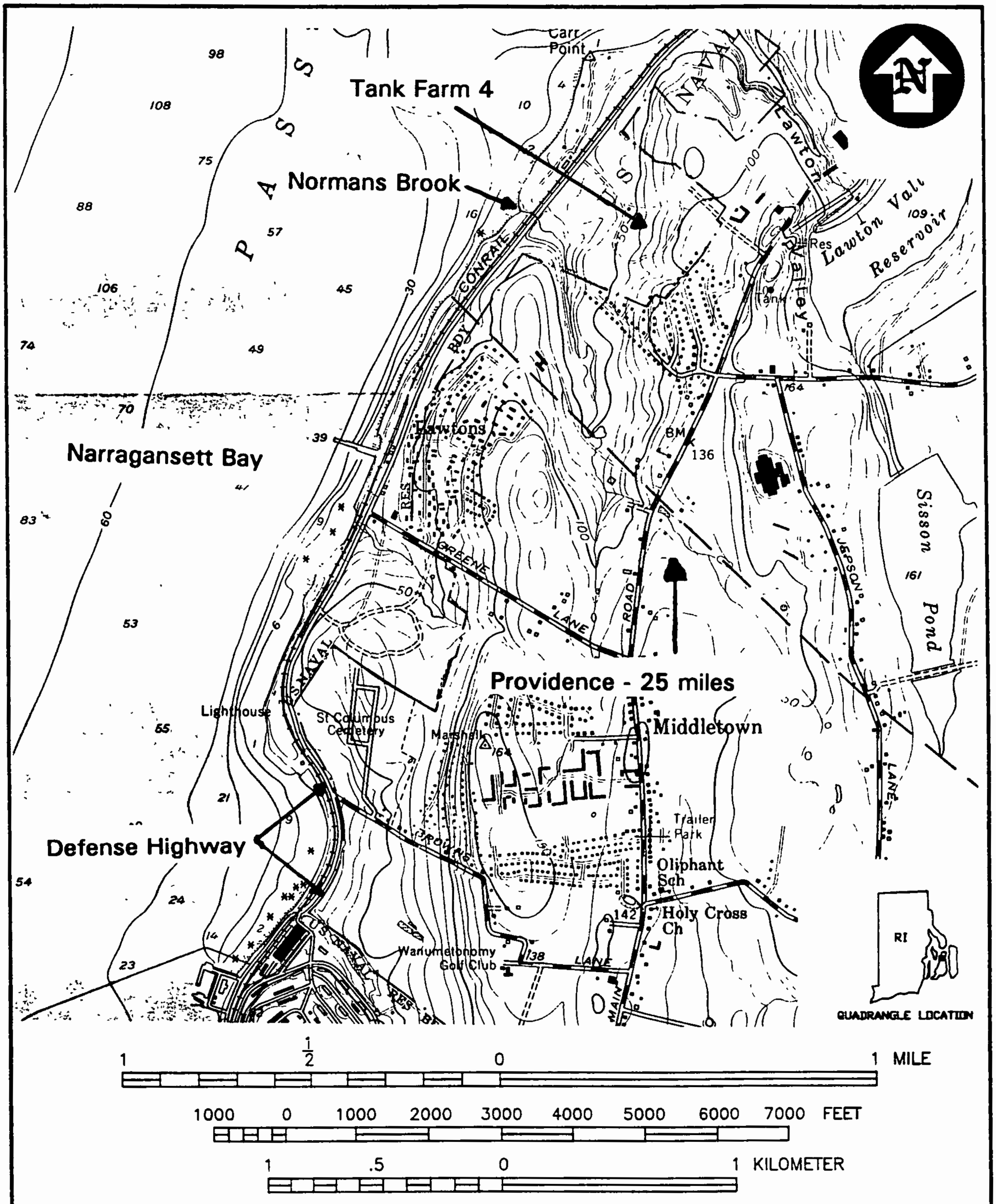
NETC Newport is located in the Towns of Newport, Middletown, and Portsmouth, Rhode Island, approximately 25 miles southeast of Providence (Figure 2-1). Tank Farm 4 consists of 90 acres situated in the northern portion of the NETC, in Portsmouth (Figures 2-1 and 2-2). Tanks 38, 42, and 45 are located in the northern portion of the tank farm, while Tank 48 is located in the southern portion (Figure 2-3).

As depicted on the figures listed above, Tank Farm 4 is bordered by Defense Highway (also referred to as Burma Road) to the north/northwest; Norman's Brook to the southwest; residential property to the southeast; and undeveloped woodlands to the north/northeast. The western edge of the tank farm is bounded by Defense Highway, the Penn Central Railroad right-of-way, and open recreational area owned by the Navy. Beyond these properties to the west is Narragansett Bay, located approximately 1,000 feet downgradient of the tank farm.

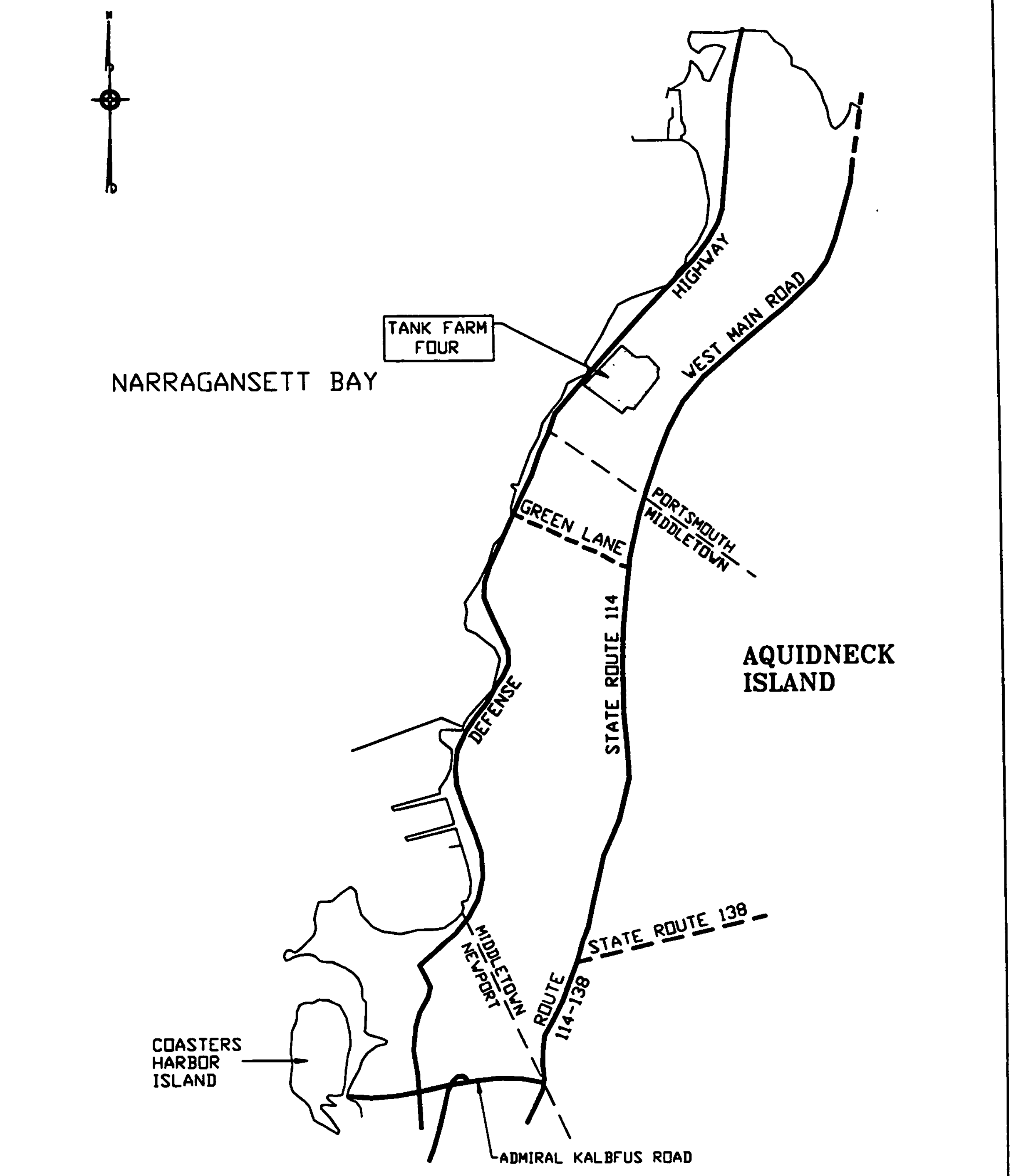
2.2 SITE HISTORY

Tank Farm 4 was constructed as a war measure from 1942 to 1943 on property owned by the Navy to support the fueling requirements of the Newport-based Atlantic Fleet (TRC, 1994). The tank farm consists of 12 2.52-million-gallon concrete underground storage tanks (USTs), which were used to store heavy fuel oil and No. 2 fuel oil from World War II until the mid-1970s. For a brief period, from 1974 to 1978, three to four unidentified tanks were reportedly leased to Northeast Petroleum (Martin, 1995a). The tanks were used to store No. 2 heating oil. At the end of the lease period, Northeast Petroleum did not require the storage capacity. The company reportedly cleaned the tanks and terminated the lease arrangement. Tank Farm 4 was not used for petroleum storage after this time.

As a result of amendments to State of Rhode Island regulations promulgated in 1993 concerning the management of underground petroleum storage facilities, tanks used to store fuel oil became subject to state UST closure requirements. On February 18, 1994, the Navy filed an application with RIDEM



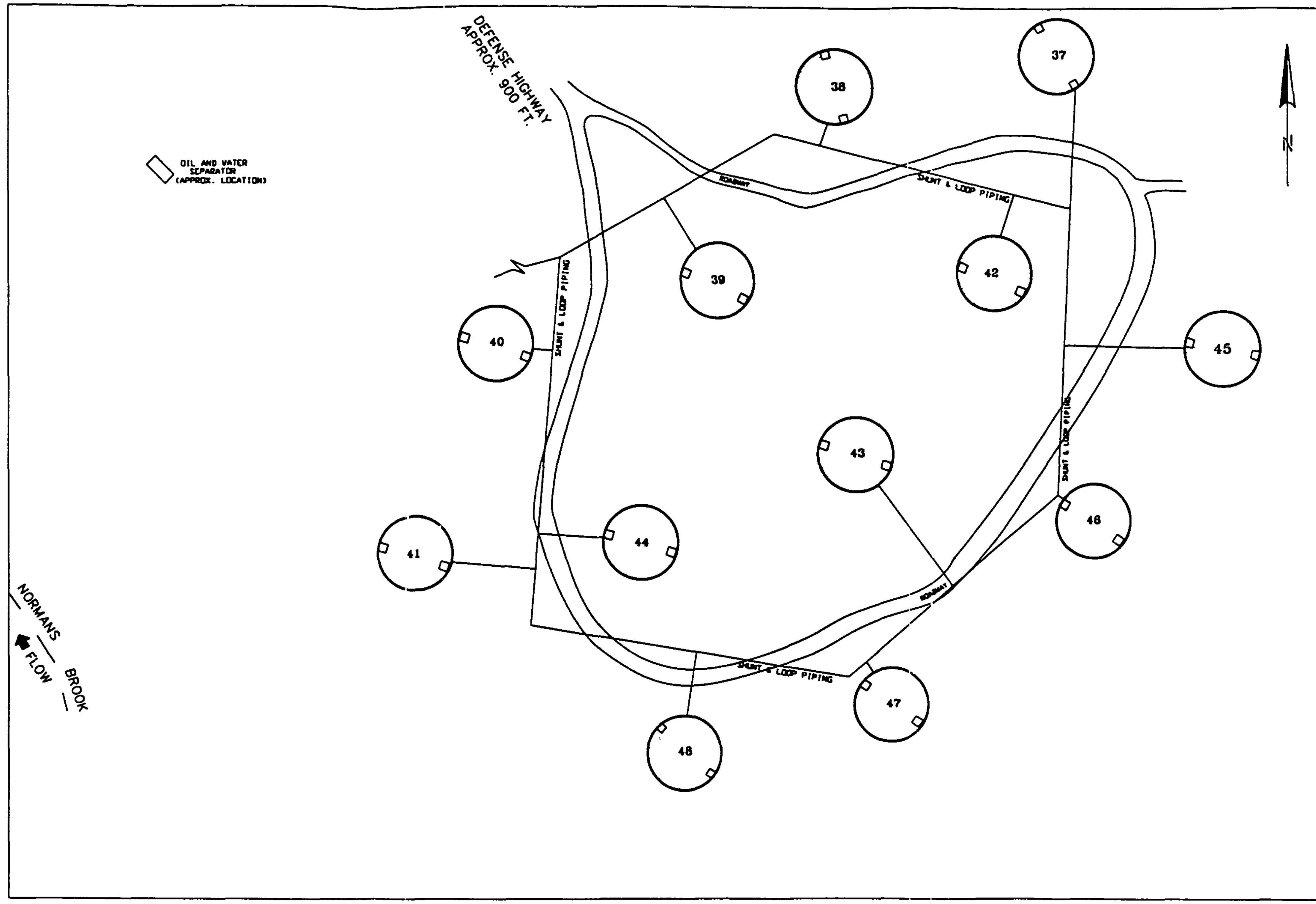
LOCATION MAP				FIGURE 2–1
NETC – NEWPORT, RI				
SITE INVESTIGATION REPORT – TANK FARM 4				Brown & Root Environmental
DRAWN BY:	R. DEWSNAP	REV.:	0	A Division of Halliburton NUS Corporation
CHECKED BY:	W. MARTIN	DATE:	23 FEB 96	55 Jonspin Road Wilmington, MA 01887 (508)658–7899
SCALE:	AS SHOWN	PROJECT NO:	0288 CTO #143	



TANK FARM 4 LOCATION				FIGURE 2-2
NETC – NEWPORT, RI				
SITE INVESTIGATION REPORT – TANK FARM 4				**Brown & Root Environmental**
DRAWN BY:	R.G. DEWSNAP	REV.:	0	*A Division of Halliburton NUS Corporation*
CHECKED BY:	J.B. HOLDEN	DATE:	23 FEB 96	55 Jonspin Road Wilmington, MA 01887 (508)658-7899
SCALE:	APPROX. 4800 FT.	PROJECT NO.:	4643 CTO #196:	

LEGEND

48 UNDERGROUND STORAGE TANK



TANK FARM 4

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)

1 INCH = 200 FT.

NOTES:

1) TANKS, ROADWAY, AND SHUNT & LOOP PIPING LOCATIONS FROM AVAILABLE PLANS AND ARE TO BE CONSIDERED APPROXIMATE
2) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
3) PLAN NOT TO BE USED FOR DESIGN.

LOCATION MAP - TANK FARM 4			
NETC-NEWPORT, RI			
SITE INVESTIGATION REPORT- TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J.B. HOLDEN	DATE:	23 FEB 96
SCALE.	1" = 200'	FILE NO.: D:\DWG\NETC\SI-38-48\TANKFM4	

FIGURE 2-3

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F

to permanently close the tanks at Tank Farm 4 (B&R Environmental, December 1995a). Tank cleaning and ballasting was initiated at Tank 42 by OHM Remediation Services, Inc. (OHM). Closure activities were conducted beginning August 28, 1995 and were completed January 3, 1996. Closure of the other 11 tanks at Tank Farm 4 is scheduled for 1996.

2.3 PREVIOUS INVESTIGATIONS AND REGULATORY HISTORY

This section presents a brief summary of past investigations conducted in response to regulatory requirements.

2.3.1 Regulatory Requirements

State of Rhode Island regulations pertaining to UST registration, operation, and closure are addressed in State Regulation DEM-DWM-UST05-93 and further detailed in the December 1993 RIDEM guidance document entitled: "Regulations For Underground Storage Tank Facilities Used For Petroleum Products And Hazardous Materials" (RIDEM, 1993a).

2.3.2 Summary of Previous Investigations and Regulatory History

Previous investigations conducted at Tank Farm 4 from 1982 to 1992 focused on assessing impacts of site activities on the entire tank farm. Investigations were preliminary, and included installing widely spaced monitoring wells and conducting preliminary soil sampling throughout the tank farm. This SI report is the first comprehensive investigation focusing on potential impacts to soil and groundwater from potential releases of petroleum from Tanks 38, 42, 45, and 48. Prior investigations are referenced for historical information purposes only (Table 2-1).

An Initial Assessment Study (IAS) was conducted by Envirodyne Engineers, Inc. in 1982 and 1983. The IAS identified Tank Farm 4 as a site where contamination was suspected to exist and which might pose a threat to human health or the environment (TRC, 1992). This investigation focused on the reported disposal of tank bottom sludges at the tank farm. Although the report did not specifically cite tanks located at Tank Farm 4, the report concluded that potential environmental impacts resulting from releases of petroleum existed, and further investigation at each of the NETC Newport tank farms was warranted.

TABLE 2-1
SUMMARY OF INVESTIGATIONS
SITE INVESTIGATION REPORT, TANK FARM 4
NETC - NEWPORT, RHODE ISLAND

YEAR	DESCRIPTION OF STUDY	CONTRACTOR
1983	Initial Assessment Study - Tank Farm 4	Envirodyne
1992	Phase I Remedial Investigation - Tank Farm 4	TRC
1994	Closure Plan and Conceptual Design Report - Tank Farm 5	TRC
1994	Preliminary Closure Assessment Investigation - Tank Farm 4	Halliburton NUS
1995	Release Characterization Reports - Tanks 38, 42, 45, and 48	Halliburton NUS
1995	Site Investigations - Tanks 38, 42, 45 and 48	B&R Environmental
1995	Tank Closure Assessment Report - Tank 42 - Tank Farm 4	B&R Environmental

A Phase I Remedial Investigation (RI) of Tank Farm 4 was initiated by TRC in 1990. As part of the RI, soil, groundwater, and soil gas sampling and analysis were conducted at Tank Farm 4. TRC reported that "significant" levels of contamination were not identified at Tank Farm 4. However, additional studies were recommended by TRC to further define the extent of total petroleum hydrocarbons (TPH) in surface soils, and to determine the significance of elevated metals concentrations in the soil and groundwater (TRC, 1992).

In November 1994, TRC prepared a Closure Plan and Conceptual Design for nine underground storage tanks at Tank Farm 5 that are regulated under the State of Rhode Island UST program. The objective of the plan was to evaluate closure alternatives, describe closure methodologies, provide closure cost estimates, and evaluate environmental permit requirements. The preferred option, temporary closure, was recommended by TRC for the nine tanks that were used to store virgin petroleum at Tank Farm 5 (TRC, 1994). Design documents were prepared for Tank Farm 5, based on the conceptual design.

Based on the similarities of age, construction methods, and location, design documents prepared for Tank Farm 5 were also used for Tank 42 closure activities (Martin, 1996).

A Preliminary Closure Assessment (PCA) investigation was conducted by B&R Environmental from October to December 1994. The PCA report (HNUS, 1995a) was submitted to RIDEM in June 1995. Consistent with the usage of Tank Farm 4 as a storage facility for virgin fuel oil, the investigation focused on evaluating soils and groundwater for the presence of petroleum components. Results of the PCA indicated that coarse-grained soils below the water table exhibited petroleum staining and elevated concentrations of TPH. Subsequent analysis of the soil samples indicated the composition of the TPH ranged from a No. 6 to No. 2 fuel oil. Finer grained soils were typically free of visual petroleum contamination.

Release Characterization Reports addressing Tanks 38, 42, 45, and 48 were prepared by B&R Environmental and submitted to RIDEM by NETC on June 26, 1995.

The Draft Closure Assessment Report for Tank 42 was submitted to the Navy on December 26, 1995. It's objective is to provide documentation to complete tank closure consistent with RIDEM UST regulations. Based on available data, the Draft Closure Assessment Report concluded that petroleum product identified as No. 6 fuel oil was released to the environment at Tank 42.

2.4 NATURE OF HISTORICAL RELEASES

Investigations conducted by B&R Environmental indicated that a possible release of petroleum had occurred at Tanks 38, 42, 45, and 48. The releases presumably occurred over an extended period prior to initiating tank closure activities. No historical documentation exists of releases from the tanks.

The releases impacted fill materials and soils below the water table. Petroleum-impacted soils below the water table were confirmed during PCA and SI field work. The impacted soils are generally petroleum stained coarse-grained fill materials with occurrences of residual non-aqueous phase liquids (NAPL) product (HNUS, 1995a). Soil samples collected during the PCA were analyzed by Ceimic Laboratories using EPA Method 8015, which identifies the petroleum product being analyzed. Analytical data indicates that the character of the petroleum present in soils adjacent to the tanks is consistent with the tanks storage of virgin heavy fuel oil, and possibly No. 2 fuel oil.

As part of the Tank Closure Inspections, a structural inspection of the tank interior is conducted by the Navy's tank closure contractor. Mr. Peter Veneto, P.E., of Stone and Webster Corporation, an engineering consulting subcontractor to OHM Corporation, inspected the interior of Tank 42 to assess its structural integrity. During the inspection, Mr. Veneto identified several minor random cracks (less than 1/8 inch wide) on the floor and intermittent hairline cracks running circumferentially around the tank wall. These cracks were considered insignificant, and required no sealing. From the structural inspection, it could not be determined if the cracks had, or had not leaked (Appendix A). The pump chamber was not inspected. Structural inspections will be conducted as part of the closure process for Tanks 38, 45, and 48, scheduled later in 1996.

The possibility that petroleum was released through a network of cracks in the tank floor may explain the presence of petroleum-impacted soils in the tank sockets (excavated area in which the tank was built). Heavy fuel oil must be heated to reduce its viscosity enough to permit oil transport through the supply piping. The tanks were equipped with a steam coil heating system, which maintained a temperature and viscosity sufficient to allow the oil to flow.

When the quantity of petroleum in the tank rose to a level at which the hydrostatic pressure within the tank exceeded that of the groundwater outside the tank, the difference in pressure may have caused petroleum to flow through cracks in the tank floor and be released to the environment.

2.5 SITE DESCRIPTION

The following section presents a description of site features and physiography. Figure 2-1 presents a portion of a United States Geological Survey quadrangle sheet that shows pertinent site surficial features (USGS, 1975).

2.5.1 Site Features

Tank Farm 4 occupies approximately 90 acres and is the site of 12 USTS, numbered 37 through 48. Tank 42 was cleaned in 1995; the other 11 tanks are scheduled for closure in 1996. Each has a capacity of 60,000 barrels (standard petroleum), or approximately 2.52 million gallons, and were used to store virgin heavy fuel oil, including No. 6 fuel oil or bunker oil. The tanks may also have been used to store No. 2 fuel oil (TRC, 1992).

Access to Tank Farm 4 is unrestricted and is gained via Defense Highway. A paved road leads into the central portion of the farm, passing between the tanks in a loop. The entire tank farm is surrounded by a chain-link fence; however, the fence is in a state of disrepair, is unsecured at the access roadway, and is breached adjacent to residential areas.

2.5.2 Buildings

On-site structures include: a small metal building that housed an electrical substation located near the split in the access road; an abandoned oil/water separator on the southeastern portion of the site; a wooden barn on a small road at the northeastern corner; and a cement building on the access road. None of the structures is presently in use.

2.5.3 Topography

The site topography generally slopes to the west. Ground elevations at Tank Farm 4 range from approximately 25 feet above mean low water (MLW) in the western corner of the tank farm to 120 feet above MLW in the eastern corner of the site (TRC, 1992; Federici and Associates, 1996). Ground elevation in the vicinity of the tanks is shown in Table 2-2.

TABLE 2-2
GROUND ELEVATION IN THE VICINITY OF THE TANKS
TANKS 38, 42, 45, AND 48
SITE INVESTIGATION REPORT, TANK FARM 4
NETC - NEWPORT, RHODE ISLAND

TANK	ELEVATION (feet, mean low water)
38	67
42	89
45	111
48	63

2.5.4 Surface Water and Wetlands

Surface water drainage in the southern portion of Tank Farm 4 was modified with engineering controls to redirect runoff toward the Normans Brook drainage basin. Normans Brook transects the southwestern portion of the tank farm and flows westerly, to Narragansett Bay (Figure 2-3). The north and central portions of the tank farm drain westerly toward Narragansett Bay. A formal wetlands delineation has not been conducted at Tank Farm 4.

2.5.5 Vegetation

Vegetation on site consists of tall grasses, dense brush, and small trees less than 12 inches in diameter. Vegetation was cleared and grubbed to provide access for equipment and personnel during closure actions.

2.5.6 Water Supply Wells

A review of Newport Water Department records by B&R Environmental in March 1995 did not identify any private or public potable water supply wells located on or downgradient of the site (Jalkut, 1995a).

2.5.7 Public Sewer and Water Lines

B&R Environmental reviewed site utility drawings for the presence of sewer and water lines. Public utilities are not present on Tank Farm 4. However, a base-operated water supply network provides water to on-site fire hydrants. Portions of the water system are currently in use. The water lines are located approximately 6 to 8 feet below ground surface (bgs) (Jalkut, 1995b). In comparison to water levels measured in December 1995, these lines are approximately 1 to 18 feet above the water table, depending on their location at the tank farm.

2.5.8 Waste Disposal Systems

No private or public sewage or other waste disposal systems were identified at the tank locations.

2.5.9 Locations of USTs and Piping

The locations of USTs and the associated shunt and loop piping system within Tank Farm 4 are shown on Figure 2-3.

2.5.10 Locations of Soil Borings and Monitoring Wells

The locations of soil borings and monitoring wells installed at each of the tanks as part of the PCA and SI work phases are shown on Figures 2-4 (Tank 38), 2-5 (Tank 42), 2-6 (Tank 45), and 2-7 (Tank 48). Additional discussion of data collected from the borings and wells is provided in Sections 3.0 through 7.0.

2.6 SUMMARY OF THE TANK FARM FACILITY

This section describes the construction methods, components, and functions of the tank farm facilities, including the UST, piping, and pump chamber. Construction reports and drawings indicate similar construction methods and dimensions were used throughout Tank Farm 4 (Maguire and Associates, 1944).

2.6.1 Tank Construction

The following is a review of the tank construction activities as described in the "UST Closure Plan and Conceptual Design for Tank Farm 5" (TRC, 1994) because construction methods used in Tank Farm 4 are similar to those used at Tank Farm 5, and closure documents prepared for Tank Farm 5 are generally applicable to closure activities planned at Tank Farm 4. Additional information is included in the historical document, "Technical Report and Project History, Underground Storage of Liquid Fuel Along Waterfront South of Naval Net and Fuel Depot, Melville, Rhode Island" (Maguire and Associates, 1944).

The tank construction sequence began by stripping the soil overburden (approximately 10,000 cubic yards) to the bedrock surface (Figure 2-8). An additional 10 to 30 feet of rock was blasted and excavated to prepare a sub-grade. Excavation of the blasted material created a steep-walled bedrock socket in which the tank was built. As observed by B&R Environmental personnel during the excavation activities conducted by OHM at Tank 53 (Tank Farm 5), the typical tank socket may taper

LEGEND

38-SB415 — SOIL BORING LOCATION WITH IDENTIFIER

TF4-MW125 — MONITORING WELL LOCATION WITH IDENTIFIER

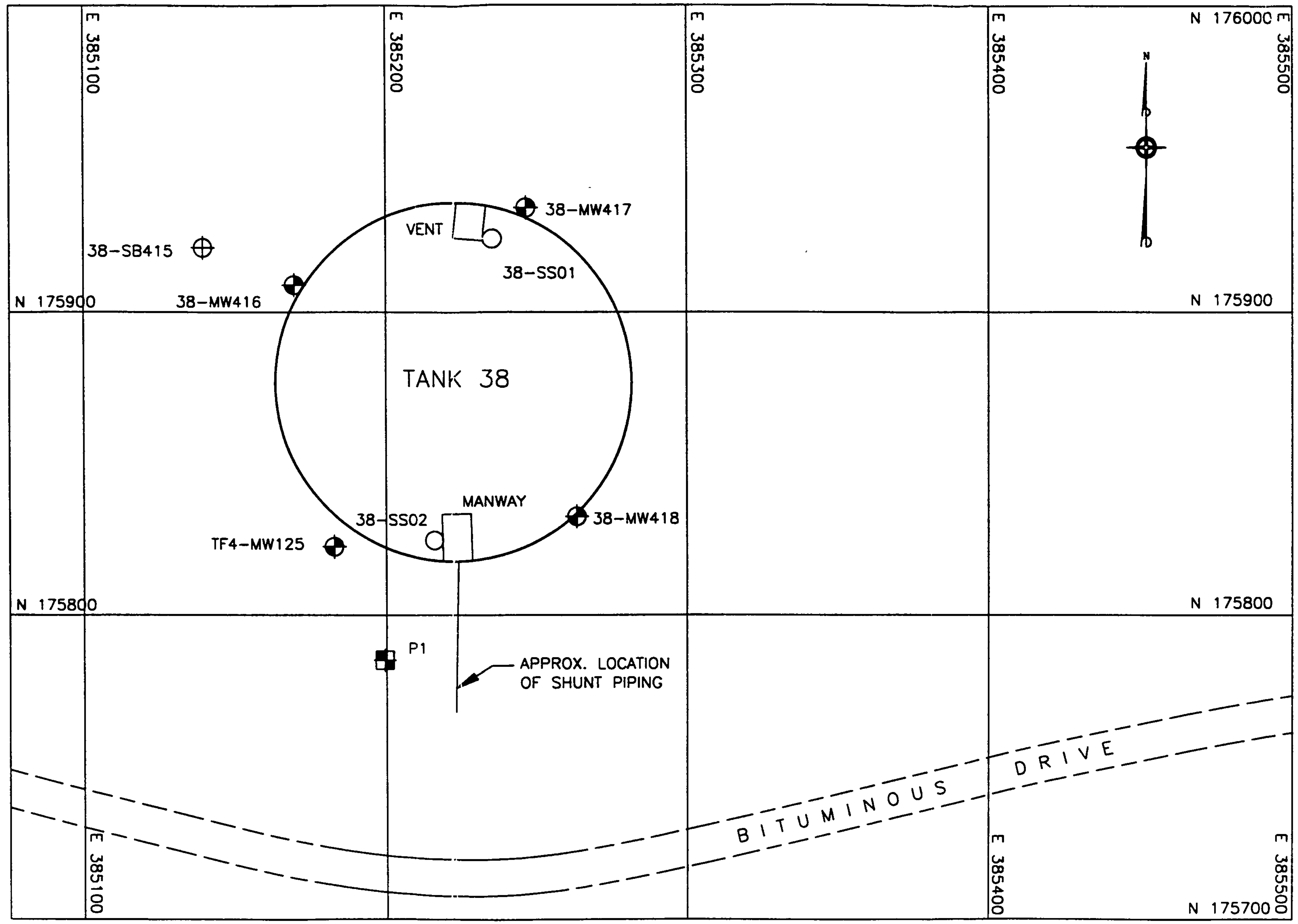
P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

38-SS01 — SURFACE SOIL SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

BORING & SAMPLING LOCATIONS – TANK 38			
NETC–NEWPORT, RI			
SITE INVESTIGATION REPORT – TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J.B. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 40'	FILE NO.:	O:\DWG\NETC\SI-38-48\FIG_2-4

FIGURE 2-4

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

LEGEND

38-SB415 — SOIL BORING LOCATION WITH IDENTIFIER

TF4-MW125 — MONITORING WELL LOCATION WITH IDENTIFIER

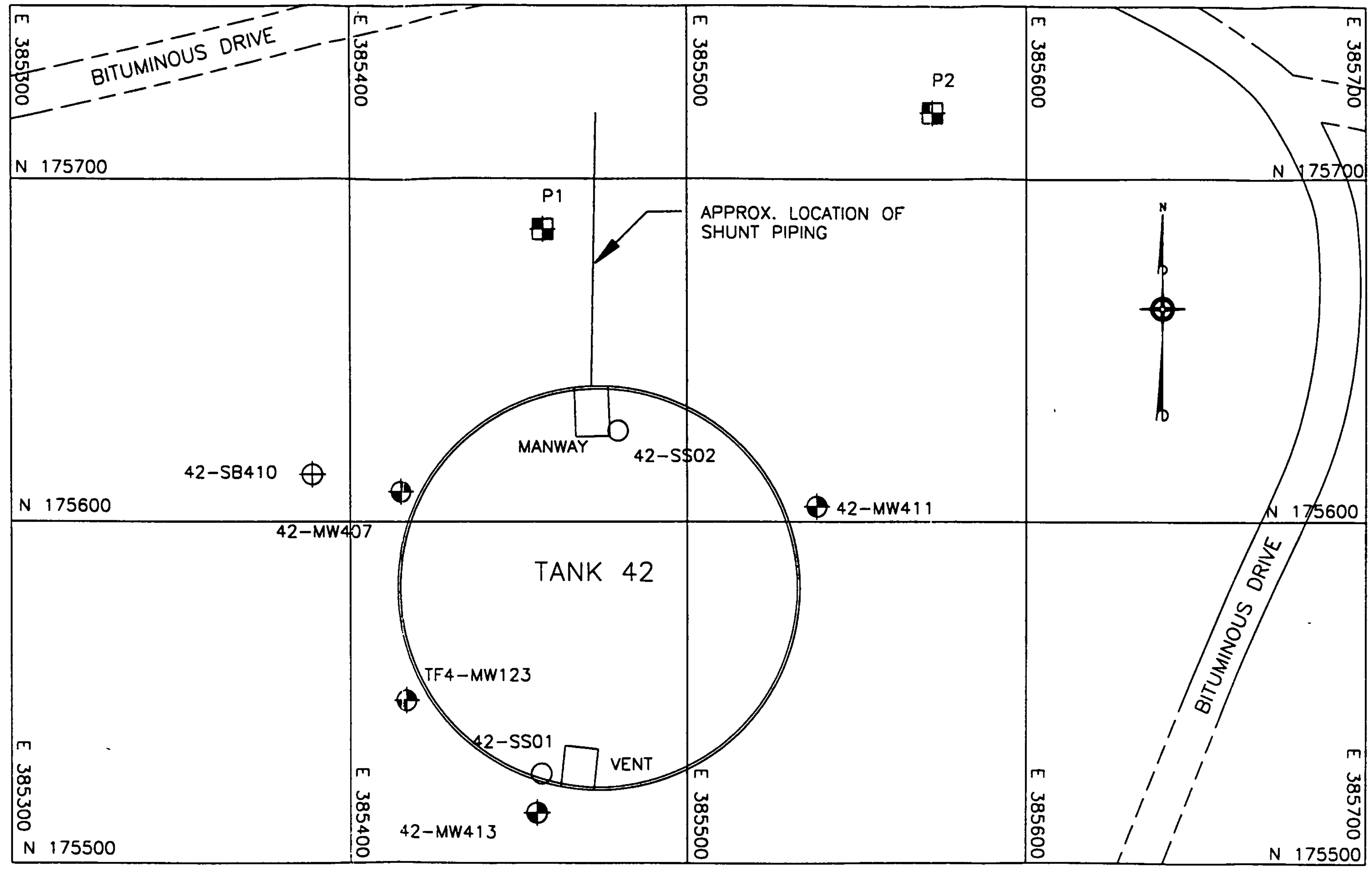
42-SS02 — SURFACE SOIL SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES:

1) PLAN NOT TO BE USED FOR DESIGN
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

BORING & SAMPLING LOCATIONS - TANK 42				FIGURE 2-5
NETC-NEWPORT, RI				
SITE INVESTIGATION REPORT - TANK FARM 4				Brown & Root Environmental A Division of Halliburton NUS Corporation 55 Jonspin Road Wilmington, MA 01887 (508)658-7899
DRAWN BY:	R.G. DEWSNAP	REV.:	0	
CHECKED BY:	J.B. HOLDEN	DATE:	16 FEB 96	
SCALE:	1" = 40'	FILE NO.: D:\DWG\NETC\SI-38-48\FIG_2-5		

W5296104F

LEGEND

45-SB333 — SOIL BORING LOCATION WITH IDENTIFIER

45-MW330 — MONITORING WELL LOCATION WITH IDENTIFIER

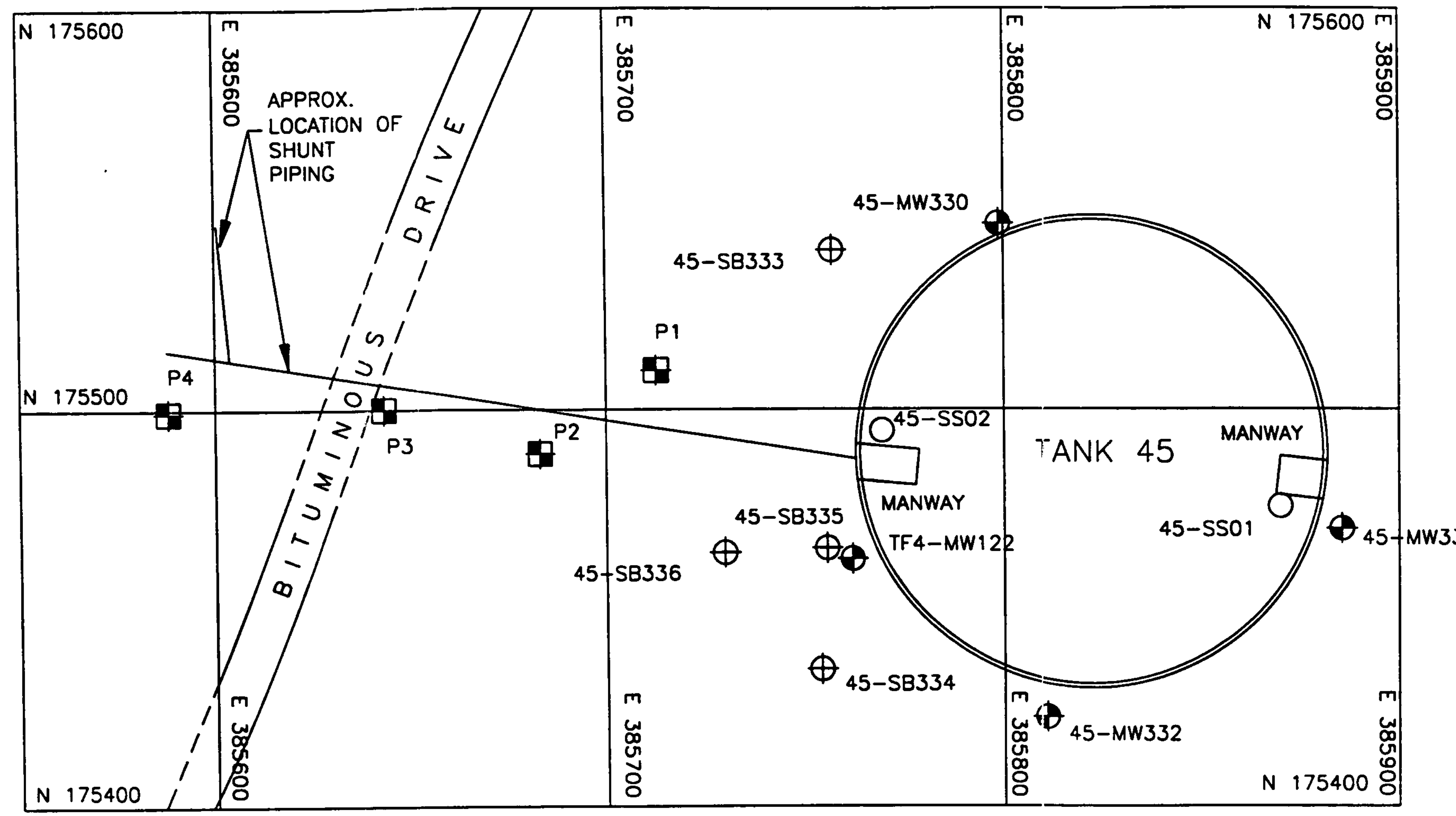
45-SS02 — SURFACE SOIL SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES

1) PLAN NOT TO BE USED FOR DESIGN.
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

BORING & SAMPLING LOCATIONS – TANK 45			
NETC–NEWPORT, RI			
SITE INVESTIGATION REPORT – TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J.B. HOLDEN	DATE:	16 FEB 96
SCALE:	1" = 40'	FILE NO.:	D:\DWG\NETC\SI-38-48\FIG_2-6

FIGURE 2-6

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

LEGEND

48-SB419 — SOIL BORING LOCATION WITH IDENTIFIER

48-MW425 — MONITORING WELL LOCATION WITH IDENTIFIER

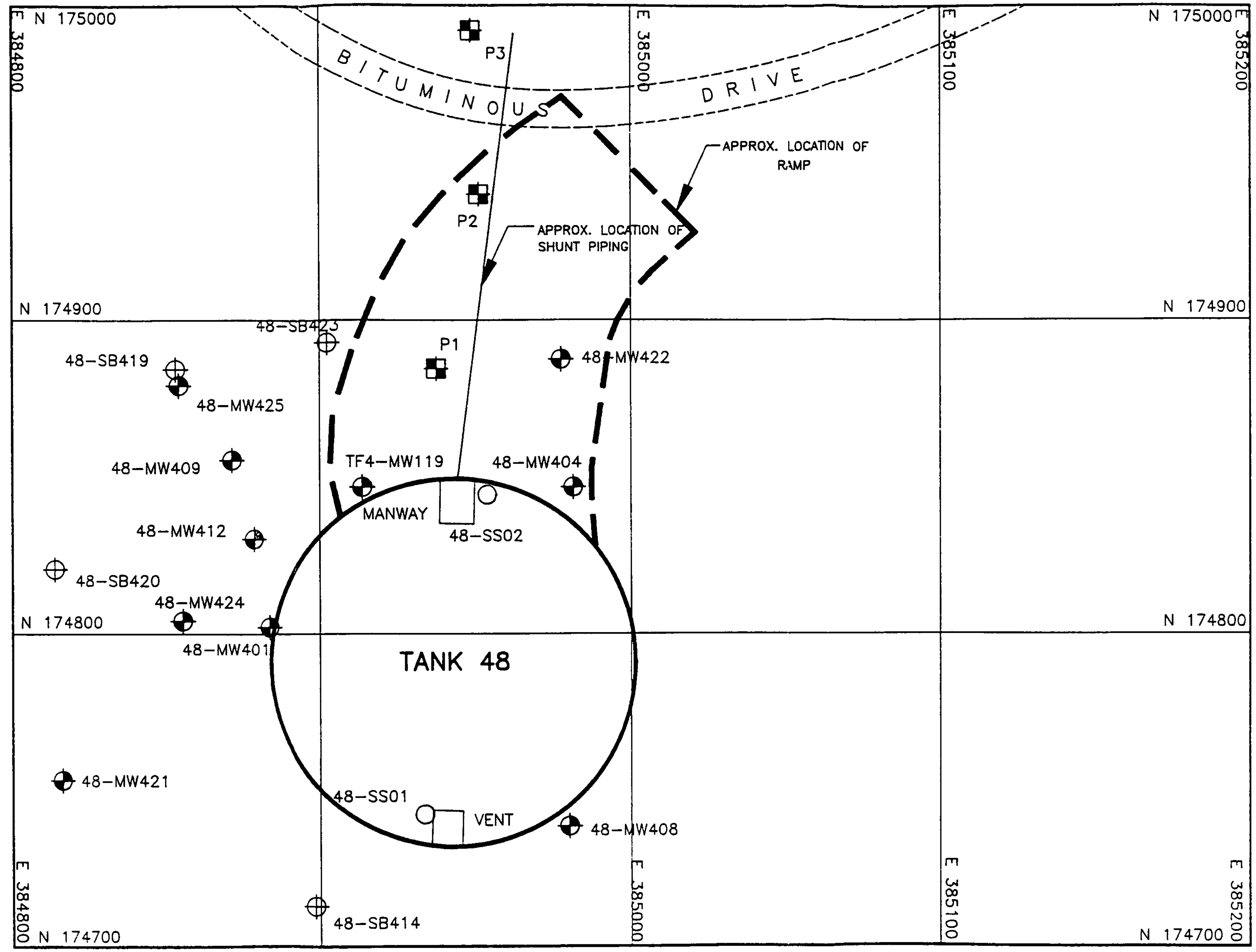
48-SS02 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET

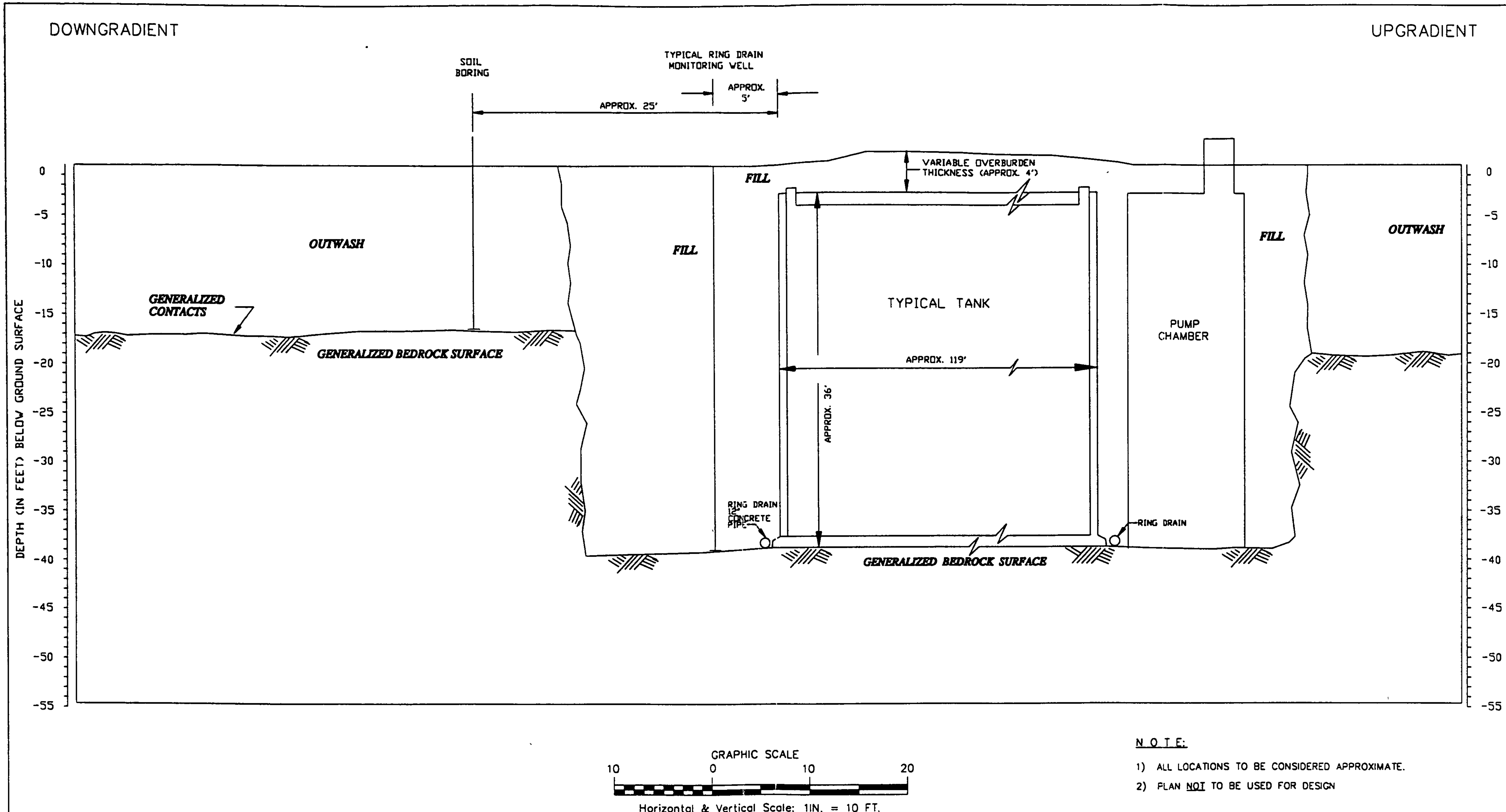


NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

BORING & SAMPLING LOCATIONS – TANK 48		FIGURE 2-7
NETC-NEWPORT, RI		Brown & Root Environmental
SITE INVESTIGATION REPORT – TANK FARM 4		A Division of Halliburton NUS Corporation
DRAWN BY: R.G. DEWSNAP	REV.: 0	55 Jonspin Road Wilmington, MA 01887
CHECKED BY: J.B. HOLDEN	DATE: 22 FEB 96	(508)658-7899
SCALE: 1" = 40'	FILE NO.: D:\DWG\NETC\SI-38-48\FIG_2-7	

W5296104F



NOTE:

1) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
2) PLAN NOT TO BE USED FOR DESIGN

TYPICAL TANK CROSS SECTION				FIGURE 2-8
NETC-NEWPORT, RI				Brown & Root Environmental A Division of Halliburton NUS Corporation 55 Jonspin Road Wilmington, MA 01887 (508)658-7899
SITE INVESTIGATION REPORT - TANK FARM 4				
DRAWN BY:	R.G. DEWSNAP	REV.:	0	
CHECKED BY:	T. DORGAN	DATE:	04 JAN 96	
SCALE:	1" = 10' (APPROX.)	FILE NO.: D:\DWG\NETC\SI-38-48\SAMPLE		

from a radius at the ground surface of 20 feet larger than the tank, to a radius at the bottom of the tank of approximately 5 feet larger than the tank. Below the original bedrock surface, the socket wall was typically irregular, with bedrock shelves extending to within several feet of the tank wall. The excavation floor was accessed by a ramp cut into the wall of the socket. Approximately 20,000 cubic yards of bedrock material were removed to create the base for a tank.

Following excavation activities, the floor surface of the socket was leveled off by filling in low areas with concrete. Although designed to be 14-inches thick, the floor slab may likely be up to 20-inches thick depending on the amount of concrete used to fill depressions in the uneven bedrock surface. A reinforced steel framework was fabricated and the floor slab was constructed in one continuous concrete pour. Wall construction was initiated following the construction of the floor. The first stage of wall construction involved concrete reinforcement. The second stage consisted of pre-stressing the concrete wall. After wall construction was completed, concrete was poured for the roof. A man-way was constructed in the roof to provide direct access to the interior of the tank.

The tanks have a design capacity of 60,000 barrels (standard petroleum), or approximately 2.52 million gallons. The tanks were constructed, in-place, of steel reinforced concrete. Concrete thickness in the tank walls and roof is a nominal 12-inches, while the thickness of a tank floor is 14- to 20-inches. Floor and wall joints were caulked at the time of construction. The outside diameter of the tanks is 119 feet, and they measure 36 feet from the bottom of the floor slab to the top of the roof.

Following tank construction, a 12-inch-diameter reinforced concrete "ring drain" pipe was installed approximately 12 inches outside of the tank footing. Groundwater can enter the ring drain pipe through the piping joints, which are not caulked. Water that enters this pipe can be pumped out of the system, thus managing the water table elevation in the immediate vicinity of the tank and thereby limiting the buoyant forces on the tank.

A pump chamber is located at each tank and is within approximately 5 feet of the tank, as shown on Figure 2-8. The pump chamber houses equipment to heat and pump fuel oil, collect tank bottom sediment and water (BSW), and pump groundwater from the ring drain. The chamber is constructed of materials similar to the USTs. The bottom of the pump chamber is located slightly below the base of the tank, however this distance was not measured. At the base of the tank, three 10-foot-long pipelines extend into the tank's interior from the pump chamber. These lines are 6-inch, 10-inch, and 16-inch in diameter. The piping was visually inspected for cleanliness and integrity by engineers for Stone & Webster and B&R Environmental, during closure activities and reported in the individual tank closure report for each tank (see references).

Construction details of the ring drain pipe were observed by B&R Environmental personnel during excavation activities conducted by OHM at Tank 53. The ring drain was located at the approximate elevation of the tank floor. Backfill around the drain consisted of well rounded, 2- to 3-inch diameter rock. Several small areas were backfilled with what appeared to be locally derived bedrock boulders and cobbles. Little fine-grained soils were present in the ring drain matrix.

Following tank completion, the annular space between the tank wall and the bedrock was backfilled with crushed bedrock and other locally derived materials (Figure 2-8). Coarse- to fine-grained materials were used, resulting in a general graded backfill with coarse bedrock "lumps" at the bottom, and finer (3/4-inch diameter) bedrock at the top. Interbeds of silt, sand, and open work (lacking fine-grained soil matrix) gravels were also present in the backfill. After backfill operations were completed, the tank top was covered with up to 4 (typical) feet of similar fill material and topsoil (Maguire & Associates, 1944).

Maguire (1956) later reported that the ring drain performance was being impaired by several factors including:

- Undersized piping used as a collector pipe accepting discharge from multiple ring drains, resulting in the system backing up
- Flooding of pump chambers resulting in pump malfunctions during periods when the system was required to manage high groundwater conditions
- Excessive infiltration of runoff into permeable backfill surrounding the tanks entering the ring drain, resulting in exceeding the system capacity
- Clogging of the ring drain pipe with silt, resulting in a reduced system capacity

Maguire proposed several remedies in a report prepared in 1956. By that time, however, a remedy consisting of a "concrete collector sump and a 14-inch gravity [draining] pipe having the invert located slightly above the tank bottom" (Maguire, 1956) was implemented at Tank 41. The report also suggests that the drain was intended to manage groundwater levels at several tanks (numbers 40, 44, and 48) upgradient of Tank 41. Records indicate that the gravity drain was effective at controlling groundwater levels in the immediate vicinity of the tank, however there was no effect on groundwater levels at the upgradient tanks.

2.6.2 Shunt/Loop Piping Construction

All tanks in Tank Farm 4 are connected by an underground "shunt and loop" piping system. The piping system was designed to allow fuel to be pumped into, out of, and between tanks as well as to allow fuel recirculation within the tanks for heating purposes. Equipment in each pump chamber transfers petroleum from the tank to the main piping loop along 20- to 75-foot-long shunt piping. The shunt piping from each tank intersects the main piping loop at a location enclosed by a concrete chamber. The main piping loop feeds petroleum to a petroleum trunk line servicing the fuel piers, approximately 1 to 2 miles to the south. This same piping system was also used to transport petroleum to fill the tanks from the piers.

Five separate pipe lines comprise the loop piping system: one each for fuel, steam, condensate, water, and BSW. Individual lines diverge from the main loop piping system and connect with the shunt piping, the trunk line servicing the fuel piers, or extend to an oil-water separator. Tank inspections conducted by OHM at Tank Farm 5 indicate that the shunt piping is buried 6 to 8 feet bgs (Jalkut, 1995a).

The shunt and loop piping is located in a hydraulically crossgradient location from Tanks 38, 42 and 48, so it is not likely to act as a preferential pathway to transport petroleum released from Tanks 38, 42 and 48. The shunt and loop piping is located in a hydraulically downgradient location from Tank 45. Potential impacts of a potential release from Tank 45 in the vicinity of the shunt piping were investigated during the SI.

2.7 UNDERGROUND UTILITIES

Underground utilities at Tank Farm 4 reportedly consist of water, electric, and telephone service lines. The exact location of electric and telephone networks could not be confirmed by NETC Digsafe services. In addition, the existence of the telephone network shown on Base planning maps could not be confirmed.

The telephone and electric lines are insulated for direct burial and are located at the ceiling level of each pump chamber, approximately 3 to 4 feet bgs (HNUS, 1995). These utilities would therefore be located approximately 6 to 22 feet above the water table, depending on the location in the tank farm, as measured in December 1995.

Because these lines are hydraulically crossgradient of Tanks 38, 42 and 48, it is unlikely that the backfill around these utilities would act as a preferential pathway for petroleum released from the tanks during high water table elevations. These lines are hydraulically downgradient of Tank 45; it is possible that the backfill around these utilities would act as a preferential pathway for petroleum released from the tanks during high water table elevations. Results of investigations conducted at Tank 45 are presented in Section 6.0.

2.8 CLOSURE ACTIVITIES

OHM began tank closure activities at Tank 42 on September 19, 1995, by excavating and exposing a portion of the tank roof to provide access to the tank interior. Petroleum-impacted soils were not encountered at Tank 42 during this phase of tank closure activities. Excavated soils were screened by OHM using a PID. Measurements were below established screening action levels, and soils were reused as backfill material (B&R Environmental, 1995a)

A similar excavation procedure may be conducted at other tanks during closure activities.

2.8.1 Tank Gauging and Sampling

Tank gauging activities at Tank Farm 4 were conducted by B&R Environmental from February 27 through March 3, 1995 (HNUS, 1995d). Three phases of liquid were reportedly present in each tank: oil, water, and sludge (TRC, 1994). The total thickness of liquid in each tank was initially measured. Subsequent measurements were made to determine the thickness of each discrete phase. Volume estimates for the tanks are presented in Table 2-3.

A discrete sample of each phase identified was collected and analyzed for volatile and semi-volatile organics as well as inorganics (TRC, 1992). Oil sludge was sampled for characterization for Tank 42 by OHM during tank closure activities (B&R Environmental, 1995a)

2.8.2 Tank Condition

This section briefly describes the condition of the interior of Tank 42 and summarizes the findings of the structural and closure inspections. Additional information is presented in the Tank 42 Closure Assessment Report (B&R Environmental, 1995a). Other tank inspections will be conducted following closure activities that are scheduled to be conducted in 1996.

TABLE 2-3
SUMMARY OF VOLUMES OF TANK CONTENTS
TANKS 38, 42, 45, AND 48
NETC - NEWPORT, RHODE ISLAND

TANK	OIL (gallons)	WASTEWATER (gallons)	SLUDGE (gallons)	TOTAL (gallons)
38	47,900	2,095,000	9,400	2,152,300
42	51,080	493,490	1,570	546,140
45	47,150	733,950	0	781,100
48	74,650	1,532,330	3,930	1,610,910

Structural Inspection

Mr. Peter Veneto of Stone and Webster inspected the interior of Tank 42 to assess its structural integrity. Results of the inspection were summarized in Section 2.4.

Closure Inspection

Inspection participants (RIDEM, NETC, and OHM personnel) agreed that the interior surface cleaning results were satisfactory. Complete documentation regarding the inspection and closure of Tank 42 is presented in the Tank Closure Assessment Report (B&R Environmental, 1995a).

3.0 GEOLOGY, HYDROGEOLOGY, AND WATER RESOURCES

This section presents the regional and site-specific geology, hydrogeology, and water resources information.

The regional geology discussion presented in this report is based on published reports and data collected during the SI. Much of this information was also discussed in the Phase I Remedial Investigation (TRC, 1992) and will be briefly summarized in this section. Results of the site-specific geologic, hydrogeologic, and water resources data collected during investigative tasks associated with the SI are also reported here.

3.1 REGIONAL GEOLOGY

The following section presents the regional bedrock and surficial geology pertinent to this investigation.

3.1.1 Regional Bedrock Geology

NETC is located at the southeastern end of the Narragansett Basin. This basin is a complex north-south trending synclinal mass of Pennsylvanian age sedimentary rocks and is the most prominent geologic feature in eastern Rhode Island and adjacent Massachusetts. The basin is approximately 55 miles long and varies from 15 to 25 miles wide. The western margin of the basin is in the western portion of Providence, Rhode Island, and the eastern margin runs through Fall River, Massachusetts. Exposures of older rocks on Conanicut Island and in the vicinity of Newport suggest that the southern extent of the basin is near the mouth of Narragansett Bay.

The rocks of the Narragansett Basin are non-marine sedimentary rocks of Pennsylvanian age, predominately conglomerates, sandstones, shales, and anthracite. Total thickness of the strata in the Narragansett Basin has been estimated at 12,000 feet. Many folds and some faults occur throughout the basin, but the character and amount of the folding and faulting are not clearly known.

The bedrock of the Narragansett Basin has been divided into five units that include the Rhode Island Formation, which underlies NETC Newport.

The Rhode Island Formation is the most extensive and thickest of the Pennsylvania formations in Rhode Island. The Rhode Island Formation in the northern portion of the basin is not metamorphosed.

However, in the southern portion of the basin, such as in the vicinity of the NETC, the unit is metamorphosed. Rocks are schists of various grades, phyllites, conglomerates, and feldspathic quartzite. Thin beds of metaanthracite and anthracite were mined from many areas within the basin.

3.1.2 Regional Surficial Geology

Overlying the Pennsylvanian rocks of the Narragansett Basin are surficial deposits of Pleistocene sediments.

These Pleistocene sediments owe their origin to the Wisconsin glaciation that covered the area with ice several thousand feet thick. As the glaciers began to recede 10,000 to 12,000 years ago, unconsolidated glacial materials of variable thicknesses were deposited throughout the Narragansett Basin area. The unconsolidated glacial material ranges from 1 to 150 feet thick, and is thicker in the valleys and thinner in the uplands. The glacial material consists of a loose till, and outwash deposits characterized by sands, silty sands, and gravels. These glacial deposits were derived from shale, sandstone, conglomerate, and in a few places, coal (TRC, 1992).

3.2 SITE GEOLOGY - SOIL AND BEDROCK CONDITIONS AT TANK FARM 4

The area in the immediate vicinity of the tanks is underlain by fill materials (Maguire and Associates, 1944). In-situ (undisturbed) soils are present in areas outside the tank sockets. In situ soils may be overlain by fill and regraded topsoil. The unconsolidated surficial and bedrock units at Tank Farm 4 were extensively reworked during the facility development. Sockets were blasted and excavated into the upper bedrock. The excavated bedrock materials were reused as fill material during construction of the tanks (Figure 2-8). Soils were regraded during construction of the tank farm to provide camouflage and a suitable cover over the USTs to minimize the chance of potential bomb impacts during war time.

The following section presents a description of the site geology based on field data generated during the PCA and SI studies.

3.2.1 Surficial Deposits

Results of the subsurface investigations indicate that the undisturbed site surficial deposits typify regional surficial deposits. Deposits identified on site include gravelly silty-sand (outwash), and fill materials. Geologic cross-sections were prepared from field data collected during the PCA and the SI field investigations for each of the tanks, and may be found in Sections 4.0 through 7.0

The following sections describe the unconsolidated surficial materials.

Outwash - Gravelly Silty, Sand

As described in the RI report (TRC, 1992), the gravelly silty sand deposit outside the tank sockets is interpreted to be a glacial outwash deposit. This deposit consists of poorly graded sands with varying amounts of silt and gravel, and is locally indistinguishable from fill materials. Composition of the unit is highly variable. The thickness of the gravelly silty sand unit ranges from 16 to 23 feet bgs (Appendix B).

Fill

Historical records indicate that backfilling the bedrock sockets was carefully planned and consideration was given to material characteristics to ensure proper drainage around the tank. "Shale" ranging from "large lump size" to 0.75-inch diameter was specified as backfill material. Larger pieces were deposited at the bottom with smaller pieces at the top. The backfill material was placed in shallow, successive layers around the tank to prevent eccentric loading of the tank ring. Each layer was tamped prior to depositing the next layer. Below the tank backfill, the ring drain pipe was reportedly bedded in sand, and placed 12 inches outside and level with the tank bottom (Maguire and Associates, 1944).

During the drilling program, the fill materials encountered in the tank socket were layered, and consisted of poorly graded, silty gravelly sand, gravelly silty sand, gravelly silt, silty gravel, and rock fragments. The fill is characterized by fine-grained bedrock and silt particles that form a relatively compact mass of low porosity material. The fill is interbedded with poorly graded gravels and gravel sized pieces of bedrock, with only trace amounts of fines. As described in Section 2.0, the bedrock sockets were created during initial blasting and excavation to prepare the tank sub-grade (Maguire and Associates, 1944). Based on tank dimensions and survey information, the depth to the bottom of the socket is estimated to be 40 feet bgs.

3.2.2 Bedrock

Bedrock was identified from cores collected from two borings advanced during the Tank 48 SI, as a light-gray phyllite consisting primarily of silica, mica, and chlorite. The rock is similar to bedrock core collected from Tank 50 at Tank Farm 5, and is assumed to underlie the remainder of Tank Farm 4.

The bedrock surface is characterized by a zone of highly altered and fractured rock. Locally, this zone is altered to the consistency of a silty soil. The competent rock is fractured primarily along bedding planes. Some clay alteration products and iron-oxide staining are present along bedding planes in several highly fractured zones. Petroleum product was found in numerous open and tight fractures and open fracture zones in the two bedrock borings at Tank 48 (Appendix B).

Refusal depths from borings advanced as part of the SI are interpreted as the approximate bedrock surface. These depths range from 17.5 feet bgs to 23.3 feet bgs outside the tank socket areas (Appendix B).

3.3 HYDROGEOLOGY

The hydrogeology at Tank Farm 4 was evaluated using monitoring wells installed during the PCA and the SI. These wells are screened across the water table to a depth of approximately 20 feet below the water table. Groundwater elevations were measured in December 1995 in these wells, and were used to construct an interpretive water table map (Figure 3-1). The water table map is termed interpretive because data used to compile the map was collected from wells screened several feet below the water table.

3.3.1 Interpretive Water Table Map

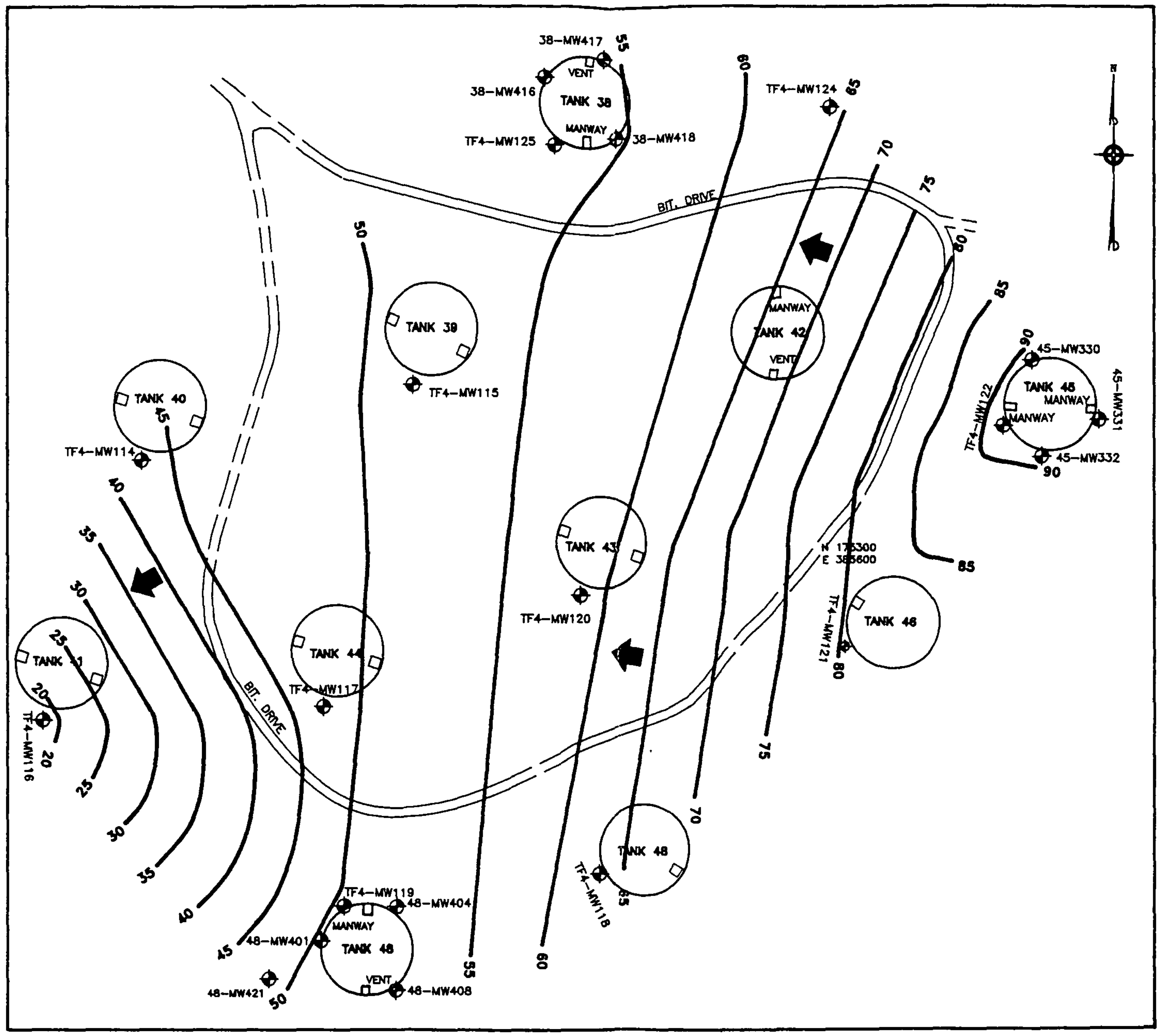
Water levels were measured to a hundredth of a foot using an electronic measuring device. The relative elevation of each monitoring well was determined by a State of Rhode Island registered land surveyor, and the depth of the water table was established using water level measurements collected in December 1995. From these data, an interpretive water table map (Figure 3-1) was compiled for Tank Farm 4. Groundwater flow directions were estimated from this map. Groundwater generally flows southwest toward Narragansett Bay, but as reported by TRC in 1992, is locally affected by Normans Brook. Normans Brook is a perennial stream that flows across the southern side of Tank Farm 4. According to previous investigations, groundwater and surface water runoff from the southern

LEGEND

48-MW422 — MONITORING WELL LOCATION WITH IDENTIFIER

35 — INTERPRETED GROUNDWATER CONTOUR LINE

INTERPRETED GROUNDWATER FLOW DIRECTION



I.D.	GW ELEV.
TF4-MW 124	63.54
TF4-MW 125	54.62
38-MW 416	54.63
38-MW 417	54.63
38-MW 418	54.63
TF4-MW 115	51.37
TF4-MW 114	44.28
TF4-MW 116	18.15
TF4-MW 120	57.96
TF4-MW 117	48.60
TF4-MW 122	91.66
45-MW 330	91.70
45-MW 331	91.57
45-MW 332	90.55
TF4-MW 121	80.18
TF4-MW 118	62.90
TF4-MW 119	50.16
48-MW 401	50.17
48-MW 404	50.12
48-MW 408	50.15
48-MW 421	49.13

GRAPHIC SCALE

0' 200' 400'

1 INCH = 200 FEET

NOTES:

1) BASE MAP FROM PLAN BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI & AVAILABLE PLANS.
2) BITUMINOUS DRIVE LOCATION FROM ABOVE PLAN & AVAILABLE PLANS AND IS TO BE CONSIDERED APPROXIMATE.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).
4) GROUNDWATER ELEVATIONS FROM TANK 42 WERE NOT USED FOR THIS MAP DUE TO PUMPING OF THE RING DRAIN AT THE TIME OF GROUNDWATER MEASUREMENTS.
5) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE
6) PLAN NOT TO BE USED FOR DESIGN.

INTERPRETED WATER TABLE MAP – DEC. 18, 1995

NETC–NEWPORT, RI

SITE INVESTIGATION REPORT – TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	1
CHECKED BY:	R. CLEAVER	DATE:	15 APR 96
SCALE:	1" = 200'	FILE NO.: D:\DWG\NETC\SI-38-48\GW_CONTR	

FIGURE 3–1

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

portion of Tank Farm 4 discharges toward or into Normans Brook (TRC, 1992). In addition, engineered surficial drainage channels and diversion berms redirect runoff in the southern portion of the tank farm toward Norman Brook (Maguire and Associates, 1956). The shape of the interpretive water table map may also significantly be effected by the gravity drain installed to provide discharge for the Tank 41 ring drain (Section 2.6.1). The groundwater elevation at Tank 41, 18 feet mean low water (mlw) (MW-116), is significantly lower than the water levels at adjacent tanks (44 feet mlw at MW-114 (Tank 40) and 48 feet mlw at MW-117 (Tank 44).

A comparison of the December 1995 interpretive water table map and the April 30, 1991 water table map presented in the site RI (TRC, 1992) indicates slight differences in groundwater flow directions across Tank Farm 4. The December 1995 map indicates a groundwater flow direction that has a more westerly component than is shown on the April 30, 1991 map. This variation may be due to two factors. Variations in groundwater flow direction may be either in response to seasonal changes in the rate of groundwater recharge, or the result of using two distinct monitoring well networks for each set of measurements. The differences in the two water table maps, however, are not considered significant to the investigation.

3.3.2 Hydraulic Conductivity Measurements

The hydraulic conductivity of the fill, overburden, and bedrock units was measured during the SI conducted at Tank Farm 4 (Tank 45 and Tank 48) and Tank Farm 5 (Tank 50), (B&R Environmental, 1995b). Variable head hydraulic conductivity tests (slug tests) were performed in nine monitoring wells installed at Tank Farm 4. Slug tests were also conducted by TRC as part of the RI Report (TRC, 1992). Data generated by TRC is included in the discussions presented in this report.

The Bouwer and Rice (1976) and Kruseman and de Ridder (1989) methods were used to evaluate the results of the slug tests. These methods provide order of magnitude estimates of hydraulic conductivity (Table 3-1). Field methods and additional details concerning interpretive methods are presented in Appendix F.

Interpretation of the data indicates that in-situ soils have a hydraulic conductivity between 1.4E-03 and 9.5E-04 centimeters per second (cm/sec), while the fill surrounding the Tanks has a hydraulic conductivity between 6.66E-02 and 2.5E-03 cm/sec. The hydraulic conductivity of the bedrock was between 1.0E-03 and 1.2E-04 cm/sec (Table 3-1).

W5296104F

TABLE 3-1
HYDRAULIC CONDUCTIVITY RESULTS
TANKS 45 and 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Well No.	Inside Diam. of Well (inches)	Well Screen Depth Interval (ft bgs)	Stratigraphic Unit Classification	Soil/Rock Description	Bulk Hydraulic Conductivity	
					ft/day	cm/sec
MW-119[1]	4	33.5-38.5	Fill (socket)	silty GRAVEL, poorly graded GRAVEL	NC	NC
MW-330[1,2]	2	28-38	Fill (socket)	gravelly silty SAND, sandy GRAVEL	17.14	6.1E-03
MW-331[1,2]	2	27.5-37.5	Fill (socket)	silty SAND, poorly graded GRAVEL	NC	NC
MW-408[1]	2	37-42	Fill (socket)	silty sandy GRAVEL, sandy GRAVEL	16.76	5.9E-03
MW-409	2	17-22	Outwash	silty sandy GRAVEL	3.71	1.4E-03
MW-421	2	11-16	Outwash	silty sandy GRAVEL, silty gravelly SAND	1.66	5.9E-04
MW-422	2	19-24	Fill (ramp)	gravelly silty SAND	7.02	2.5E-03
MW-424	2	26-41	Bedrock	thinly bedded, gray phyllite	2.95	1.0E-03
MW-425	2	26.5-41.5	Bedrock	thinly bedded, gray phyllite, with some highly fractured zones	1.32	4.7E-04
MW-1S[3]	2	2.5-12.5	Outwash	silty SAND	0.23	9.7E-04
MW-1D[3]	2	39-54	Bedrock	green-black shale, some fractures	0.06	2.5E-04

TABLE 3-1
HYDRAULIC CONDUCTIVITY RESULTS
TANKS 45 AND 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 2

Well No.	Inside Diam. of Well (inches)	Well Screen Depth Interval (ft bgs)	Stratigraphic Unit Classification	Soil/Rock Description	Bulk Hydraulic Conductivity	
					ft/day	cm/sec
MW-3D[3]	2	39-54	Bedrock	green-black shale, some fractures	0.03	1.2E-04
MW-5S[3]	2	16-26	Outwash	Weathered shale	0.23	9.5E-04
MW-5D[3]	2	27-42	Bedrock	green-black shale, some fractures	0.04	1.8E-04
MW-109[4]	4	7-17	Fill	Sand gravelly SILT, silty GRAVEL, silty SAND	188-77	6.66E.02

Legend:

NC - Not Calculated Because of Anomalous Response In Well
NA - Not Applicable
ft bgs - feet below ground surface
ft/day - feet per day
cm/sec - centimeters per second
1 - Wells with oscillatory responses
2 - Wells located at Tank 45
3 - Wells installed and tested by TRC (1992)
4 - Well located at Tank 50, calculations presented in the Site Investigation Report, Tank 50, Tank Farm 5 (B&R Environmental, 1995b).

3.3.3 Vertical Hydraulic Gradients

Vertical hydraulic gradients were not measured at the tanks. The investigation focused on delineating the extent of petroleum-impacted soils. Wells were not installed to gather sufficient data to measure vertical gradients.

3.3.4 Horizontal Hydraulic Gradients

The horizontal hydraulic gradient represents the change in head, measured in feet per horizontal foot of travel through a medium. Groundwater in an isotropic homogeneous aquifer will flow from areas of higher head to areas of lower head along flow lines that intersect the contour lines at right angles. The horizontal hydraulic gradient or slope was calculated using the December 1995 interpretive water table map. The average horizontal hydraulic gradient at Tank Farm 4 is approximately 0.06 feet per foot.

3.3.5 Saturated Thickness

The area of investigation is dominated by the presence of the large USTs (36-feet high by 119-feet in diameter) and an excavation backfilled with material of widely varying porosity that extends below the original bedrock surface. The saturated thickness of the aquifer in the unconsolidated materials is therefore a function of the location of the socket.

The water levels were measured in December 1995. Results indicated that the water table varied from 9 to 30 feet bgs across the tank farm. Generally, on the eastern side of the tank farm, the water table was present in the deeper portion of the socket. The saturated thickness within the sockets ranged from 12.0 to 27.5 feet, and outside the socket from 0 to 13 feet.

3.3.6 Barriers to Contaminant Migration

No qualitative evaluation was conducted on the influence of potential perturbations in the local groundwater flow regime caused by the socket and the presence of the large USTS. The socket, however, appears to be limiting the migration of free-phase petroleum in the unconsolidated aquifer.

The fill material within the socket has a significantly higher hydraulic conductivity, and thus a higher permeability than the surrounding bedrock. The surrounding bedrock acts as a lower permeability barrier, limiting the horizontal migration of free-phase petroleum. To migrate by advective forces, the petroleum must rise through the aquifer (due to its lighter specific gravity with respect to water) until it encounters more permeable in-situ soils or fill material overlying bedrock. At that point, driven by the groundwater gradient, the petroleum may migrate horizontally.

The ability of the socket to minimize migration of petroleum is evidenced during previous investigations conducted at Tank 50, Tank Farm 5. TPH concentrations in soils within the tank socket are as high as 65,000 mg/kg, while TPH concentrations in soil samples collected from borings approximately 150 feet hydraulically downgradient of the tank are below detection limits (B&R Environmental, 1995b). A similar situation exists at Tank Farm 4, and will be discussed in more detail in Sections 4.0 through 7.0.

3.4 GROUNDWATER RESOURCES AND POTENTIAL RECEPTORS

The following subsections summarize groundwater resources and identify potential receptors.

3.4.1 Site Wellhead Protection Status

The tanks are not located within a designated wellhead protection area (RIDEM "Rules and Regulations for Groundwater Quality", Section 18 and Appendix IV) (RIDEM, 1993b).

3.4.2 Site Groundwater Classification

The groundwater beneath Tank Farm 4 is classified by RIDEM as "GB" (RIDEM "Rules and Regulations for Groundwater Quality", Section 9 and Appendix II) (RIDEM, 1993b). GB-classified groundwater is primarily located under highly urbanized areas or is located in the vicinity of disposal sites for solid waste, hazardous waste, or sewage sludge. Groundwater classified as GB is not suitable for public or private drinking water use.

3.4.3 Potential Receptors

A review of Newport Water Department records by B&R Environmental in March 1995 did not identify any private or public potable water supply wells located on or downgradient of the site. Tank Farm 4 and land hydraulically downgradient of the tank farm to Narragansett Bay is owned by the federal government (Town of Middletown, 1958).

No known private wells or basements exist that could potentially be affected by the petroleum release.

4.0 TANK 38 SITE INVESTIGATION

Section 4.0 summarizes field activities conducted to evaluate the nature and extent of petroleum-impacted soils and groundwater, and effects to human health and the environment at Tank 38. The PCA evaluated the impacts to soil and groundwater of past petroleum storage and handling practices at each of the Tank Farm 4 and 5 USTs, including Tank 38. Results of the PCA indicated the need for conducting a SI at Tank 38.

Preliminary Closure Assessment

Specific soil and groundwater sampling methods and soil boring and monitoring well construction techniques are described in detail in the final Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5, dated September 1994 (HNUS, 1994). Additional RIDEM comments, which addressed initiating soil sampling at the water table, and containerizing all Investigation-Derived Wastes (IDW) were conveyed to the B&R Project Manager and the NETC representative (personal communication).

Ground penetrating radar (GPR) and utility location surveys were conducted by a subcontractor to B&R Environmental to identify the edges of the USTs and associated piping to facilitate borehole placement.

The PCA field investigation was conducted by B&R Environmental from October to December 1994. The objective of the study was to evaluate the impacts of past site activities on soil and groundwater by collecting and analyzing soil and groundwater samples. The PCA involved advancing one soil boring (B-38), and subsequently installing a groundwater monitoring well, MW-125, in the boring, on the hydraulically downgradient side of Tank 38 (Figure 4-1).

Soil sampling was initiated at 26 feet bgs, the estimated depth of the water table in MW-125, and continued to the end of the boring, approximately 39 feet bgs. Soil cuttings and air samples at each borehole were monitored with photo- and flame-ionization detectors (PIDs and FIDs). Visual and olfactory evidence of the presence of petroleum was noted on boring logs (Appendix B).

Selected soil samples were screened with an Ensys immunoassay kit for the presence of TPH. The sample that exhibited the highest concentration of petroleum, as determined by immunoassay results, was generally selected for laboratory analysis. Soil samples selected for laboratory analysis were analyzed by EPA methods for volatile and semi-volatile organic compounds, TPH, and the eight RCRA

LEGEND

38-SB415 — SOIL BORING LOCATION WITH IDENTIFIER

TF4-MW125 — MONITORING WELL LOCATION WITH IDENTIFIER

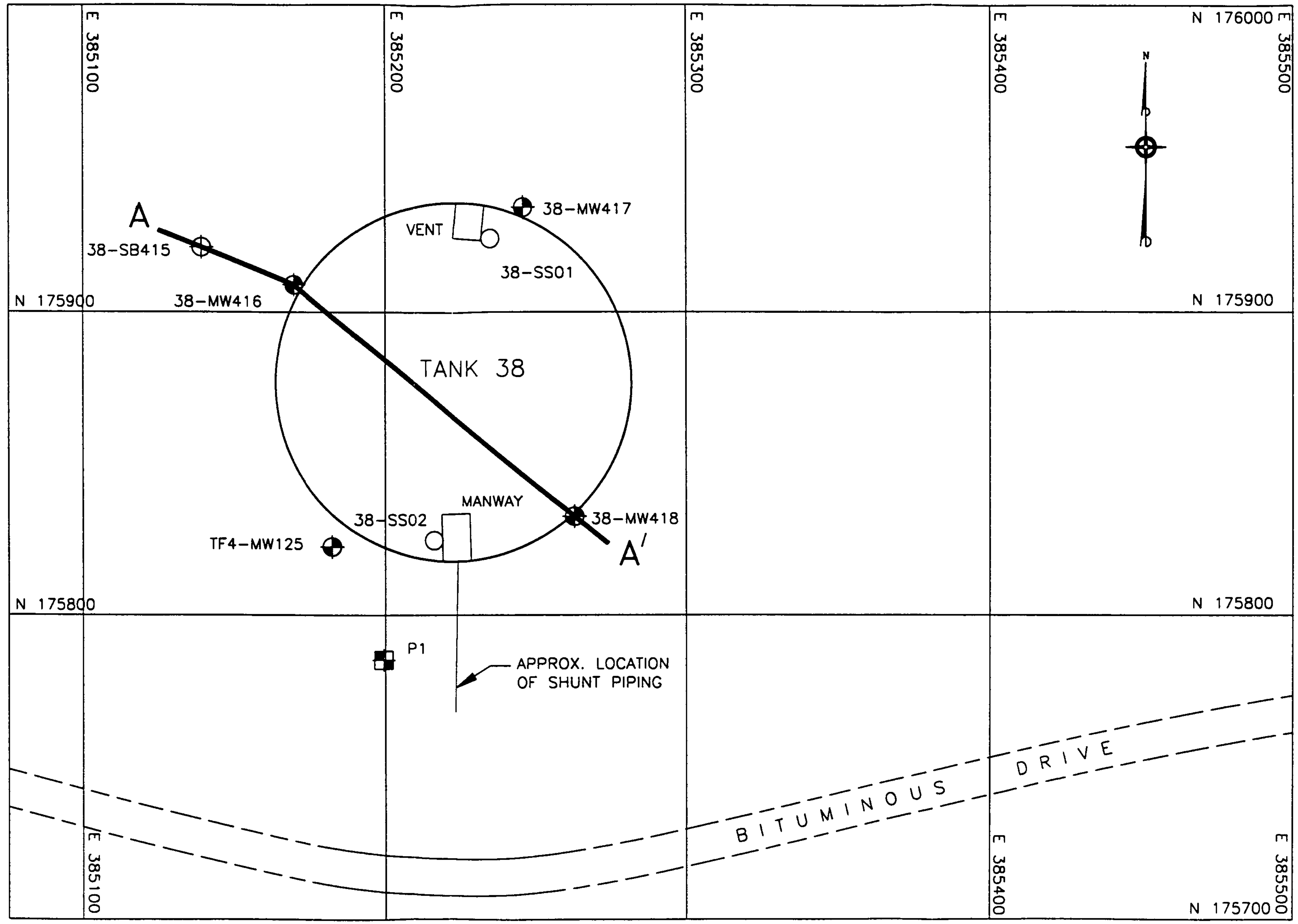
P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

38-SS01 — SURFACE SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

CROSS-SECTION LOCUS MAP - TANK 38			
NETC-NEWPORT, RI			
SITE INVESTIGATION REPORT - TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J.B. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 40'	FILE NO.: D:\DWG\NETC\SI-38-48\FIG_4-1	

FIGURE 4-1

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F

metals. Groundwater samples were analyzed by EPA methods for volatile and semi-volatile organic compounds, and the eight RCRA metals. The objective of the soil boring and groundwater monitoring well is summarized in Table 4-1.

One soil probing, P1-38, was advanced on the hydraulically downgradient side of the shunt piping at Tank 38 to evaluate the presence of petroleum-impacted soil. The probing was performed using a combination of standard solid-stem auger methods, advancing a 2.5-inch diameter drive point, and advancing an open hole with a split-spoon sampler. Two split-spoon samples were then obtained from 4 to 6 and 6 to 8 feet bgs. A review of the best available data determined that the piping lay no deeper than 5 feet bgs. Later work and investigations at Tank Farm 5 indicated that the piping is located 6 to 8 feet bgs (Jalkut, 1995b). The soil samples were screened using the Ensys Petro Risc immunoassay kit for the presence of petroleum hydrocarbons. The sample exhibiting the highest concentration of petroleum in each probing was submitted for laboratory analysis. Probing field logs are presented in Appendix B.

Site Investigation

The SI was conducted between November and December 1995, and focused on delineating the extent of TPH in soil and groundwater. During the SI field effort four soil borings were advanced and two surface soil samples were collected (Figure 4-1). Of the four soil borings, three, SB-416, SB-417, and SB-418 were advanced through the unconsolidated overburden, and completed as groundwater monitoring wells, MW-416, MW-417, and MW-418.

In SB-416, split barrel soil sampling was initiated at the ground surface and continued to refusal in order to define the vertical extent of impacted soils. In borings SB-415, SB-417, and SB-418, samples were collected at standard intervals (5-foot intervals) from the ground surface to the water table and continuous from the water table to the end of the boring, at refusal.

One boring, SB-415, was advanced to investigate potential migration of petroleum in the unconsolidated overburden downgradient of the tank outside the tank socket. Soil samples were collected and the boring was backfilled. Soil boring and well construction logs are presented in Appendix B and C, respectively. Analytical data is reported in Appendix D. The objective of each soil boring and groundwater monitoring well is summarized in Table 4-1.

TABLE 4-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
B-38/(MW-125)	PCA	Slightly crossgradient to Tank 38; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples
SB-415	SI	Downgradient of Tank 38; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
SB-416/(MW-416)	SI	Downgradient of Tank 38; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples
SB-417/(MW-417)	SI	Up- and cross- gradient of Tank 38; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
SB-418/(MW-418)	SI	Upgradient of Tank 38; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
P1	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
SS-01	SI	Top of Tank 38 roof - north side, near former location of small manway.	Provide data on presence of TPH impacted soils above the tank lid.	NA	NA
SS-02	SI	Top of Tank 38 roof - south side, near large manway with door.	Provide data on presence of TPH impacted soils above the tank roof.	NA	NA

Legend:

PCA - Preliminary Closure Assessment
SI - Site Investigation
NA - Not Applicable

4.1 ANALYTICAL METHODS

The following section summarizes analytical methods utilized during the PCA and the SI.

EPA-approved laboratory methods were used to evaluate soil and groundwater samples at the site. Detailed descriptions of specific field procedures and analytical methods are presented in the "Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5", dated September 1994 (HNUS, 1994), with Addendum 1 (HNUS, 1995c) and Addendum 2 (HNUS 1995e).

Throughout each investigation, soil and groundwater samples were collected and analyzed according to Naval Facilities Engineering Service Center (NFESC) requirements. All environmental samples collected as part of these investigations, including QC samples, were stored and shipped in accordance with chain-of custody procedures outlined in the project-specific Quality Assurance/Quality Control Plan, prepared as part of the Work Plan.

4.1.1 Field Screening

Preliminary Closure Assessment

Because Tank 38 had been used to store virgin No. 6 fuel oil and possibly No. 2 fuel oil, environmental media were analyzed for parameters typically associated with petroleum components. During the PCA investigation, soil samples were visually inspected for the presence of petroleum, and screened with PIDs and FIDs, and an Ensys Petro Risc immunoassay kit. Generally, PIDs were used for health and safety screening for VOCs, while FIDs were used for soil screening for VOCs and SVOCs. Visually impacted soils were not Ensys screened. Results of Ensys TPH screening were confirmed by laboratory analysis.

Site Investigation

During the SI investigation, soil samples were visually inspected for the presence of petroleum and screened with FIDs. Results of TPH screening were confirmed by laboratory analysis.

4.1.2 Laboratory Analysis

Preliminary Closure Assessment

During the PCA, sample analyses were conducted by Ceimic Laboratories of Narragansett, Rhode Island. Ceimic is a NFESC-approved laboratory.

EPA-approved analytical methods were used for laboratory analyses. Soil samples were analyzed for TCL volatile organic compounds (Method SW-846 8240); TCL semi-volatile organic compounds (Method SW-846 8270); and RCRA metals (Method SOW ILMO 3.0) to evaluate potential impacts to soil from sludge pits reported to exist onsite. TPH extractables (Method SW-846 8015) were analyzed to evaluate potential impacts of releases of petroleum from USTs to soil. Groundwater samples were not analyzed for TPH, but otherwise were analyzed for the same parameters.

Site Investigation

Samples collected and analyzed during the SI were analyzed for TPH (Method SW-846 418.1). Soil samples were also analyzed for several engineering parameters that will be used to evaluate potential remedial alternatives. Parameters and analytical methods include: grainsize (ASTM D421/422), moisture content (ASTM 2216), heterotrophic plate count (SM 9215 modified), sediment oxygen demand (modified BOD Method SM 5210B), chemical oxygen demand (E 410.1 modified), total phosphorus (E 365.4 modified), nitrate (SW 9200), and total organic carbon (TOC-SW/9060). TPH and most analyses were conducted by Ceimic, heterotrophic plate count by Lancaster Laboratories, and grainsize by Geotechnics. Laboratory analytical results are presented in Appendix D.

TPH extractables were analyzed during the PCA using Method 8015 to identify a petroleum fingerprint. During the SI, TPH was analyzed using Method 418.1 because the Rhode Island action level guidance is based on Method 418.1. Analysis conducted during the PCA indicated minimal concentrations of VOCs in soil and groundwater. Soils present within the investigation areas are organic-poor mineral soils. Method 418.1 analyzes the total number of carbon-hydrogen bonds in a sample, while Method 8015 is specific to petroleum hydrocarbons. The low organic characteristics of a mineral soil minimizes the potential for interference caused by elevated levels of organic compounds when using Method 418.1. Data analyzed using Method 418.1 is therefore considered roughly comparable to data analyzed using Method 8015.

4.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT

MW-125 was installed as part of the PCA field investigation and is located hydraulically downgradient of Tank 38, approximately 5 feet from its perimeter (Figure 4-1). The well screen was set 33 to 38 feet bgs to correspond with the upper layer of petroleum-impacted soil and the estimated depth of the ring drain.

The upper 26 feet of the boring were not examined. Soil sampling was initiated at 26 feet based on historical data indicating that the water table was approximately 26 feet bgs. It was presumed that petroleum releases above the water table would migrate vertically downward and be detected in soil and possibly groundwater. Soil sampling was continuous from 26 feet bgs to refusal, at approximately 39.25 feet bgs. A sandy gravel layer present at 32 to 34 feet bgs was heavily impacted by petroleum and contained residual non aqueous phase liquid (NAPL). A thin gravelly sand layer underlying the impacted zone was not visually impacted by petroleum, but did exhibit petroleum odors. Petroleum was not detected with the PID. From 36 to approximately 37 feet bgs, a coarse, angular to subangular gravel layer was noted. This interval was also visually not impacted by petroleum.

A dark-grey, metamorphic rock containing residual NAPL was encountered at refusal at approximately 39 feet bgs. The boring was terminated at 39 feet bgs. The boring log is presented in Appendix B.

On November 28, 1994, the depth to the water table was 28.92 feet bgs as measured in MW-125. Seasonal and precipitation effects on groundwater levels have not been evaluated at the site.

4.2.1 <u>Analytical Data Summary</u>

The PCA subsurface investigation included soil sampling during the advancement of MW-125 (B-38) and subsequent groundwater sample collection and analysis. Investigations conducted during the PCA focused on determining the nature of impacted soil and groundwater.

During the PCA, two subsurface soil samples (B382628 and B383234) were selected for laboratory analysis from B-38(MW-125), located near Tank 38. The samples were collected from depths of 26 to 28 feet bgs, and 32 to 34 feet bgs, and consisted of sandy gravel with silt. The latter sample was saturated with petroleum. Following standard well development and well purging procedures, a groundwater sample was collected from the midpoint of the well screen, approximately 36 feet bgs. Immiscible oil droplets were observed during groundwater sample collection.

One subsurface soil sample was selected for analysis from the soil probing downgradient of the shunt piping for Tank 38. This sample was collected from a depth of 6 to 8 feet bgs (sample P1-38-0608). Sample P1 consisted of sandy silty gravel.

Positive organic and inorganic analytes detected in soil and groundwater are reported in Table 4-2. Complete laboratory analytical results are reported in Appendix D.

4.2.1.1 Subsurface Soils in the Tank Socket

V latile Organic Compounds (VOCs)

No analytes were present above detection limits in subsurface soil sample B382628. 2-butanone was detected at a concentration of 12 micrograms per kilogram (μg/kg) in B383234. 2-butanone is also known as methyl ethyl ketone and is a common industrial solvent (Sax and Lewis, 1987).

Semi-Volatile Organic Compounds (SVOCs)

In B382628, Bis(2-ethylhexyl)phthalate [BEHP] was detected at a concentration of 74 μg/kg. Phthalates are typically used as plasticizers in the manufacturing of PVC and other plastics (Howard, 1989; Sittig, 1981), including plastics used in analytical laboratories.

Fluorene was detected in sample B383234, at a concentration of 40 μg/kg. This compound is a polynuclear aromatic hydrocarbon (PAH). It is also a constituent of fuel oil (Dragun, 1988).

RCRA 8 Metals

Arsenic, barium, cadmium, chromium, and lead were detected in both subsurface soil samples collected from B-38. Sample concentrations ranging from 2.5 to 16.35 mg/kg were reported. These metals are constituents of naturally occurring soils, however, the source of these analytes has not been determined.

Total Petroleum Hydrocarbons (TPH)

TPH concentrations were below the detection limits in both of the subsurface soil samples selected for laboratory analysis. Although petroleum was not detected by laboratory analysis, soil sample

TABLE 4-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-38	26-28	Bis(2-ethylhexyl)phthalate	74 μg/kg	None	N/A
Soil	B-38	26-28	Arsenic	12.2 mg/kg	None	N/A
Soil	B-38	26-28	Barium	12.1 mg/kg	None	N/A
Soil	B-38	26-28	Cadmium	2.5 mg/kg	None	N/A
Soil	B-38	26-28	Chromium	13.7 mg/kg	None	N/A
Soil	B-38	26-28	Lead	10.5 mg/kg	150 ppm (4) 400 ppm (5)	No
Soil	B-38	32-34	2-Butanone	12 μg/kg	None	N/A
Soil	B-38	32-34	Fluorene	40 μg/kg	None	N/A
Soil	B-38	32-34	Arsenic	16.35 mg/kg	None	N/A
Soil	B-38	32-34	Barium	10.8 mg/kg	None	N/A
Soil	B-38	32-34	Cadmium	2.95 mg/kg	None	N/A
Soil	B-38	32-34	Chromium	8.9 mg/kg	None	N/A
Soil	B-38	32-34	Lead	8.05 mg/kg	150 ppm (4) 400 ppm (5)	No
Groundwater	MW-125	33-38	1,1,2,2-Tetrachloroethane	1 μg/L	None 5	N/A
Groundwater	MW-125	33-38	Fluorene	20 μg/L	None	N/A

TABLE 4-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Groundwater	MW-125	33-38	Phenanthrene	48 μg/L	None	N/A
Groundwater	MW-125	33-38	Pyrene	28 μg/L	None	N/A
Groundwater	MW-125	33-38	Chrysene	23 μg/L	0.2 μg/L (2)	Yes

Legend:

ppm - parts per million
μg/L - micrograms per liter
mg/kg - milligrams per kilogram
μg/kg - micrograms per kilogram
N/A - Not Applicable

Notes:

(1) Comparisons to Regulatory Standards and Guidelines are discussed in Section 4.6.
(2) U.S. EPA Drinking Water Regulations and Health Advisories, EPA 822-R-94-001, May 1994.
(3) State of Rhode Island Department of Environmental Management, Rules No. 12-100-006, Rule and Regulations for Groundwater Quality, Section 10, July 1993.
(4) Rhode Island Department of Health - Environmental Lead Program, [R23-24.6-PB], Rules and Regulations for Lead Poisoning Prevention, February 1992 (with amendments).
(5) OSWER Directive 9355.4-12- Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.
(6) 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart F, Sections 264.92 - 264.94, July 1991.

- MW-125 was installed in boring location B-38.
  Analytical results of duplicates were averaged.
  For comparative purposes only, mg/kg unit designations and ppm unit designations were considered to be equivalent.

B383234 was heavily impacted. Heavy staining and the occurrence of residual petroleum was noted during advancement of the borehole.

Subsurface soil samples B382628 and B383234 were field screened for TPH using an immunoassay method. These samples were collected from 26 to 28 feet, and 32 to 34 feet bgs, respectively. TPH screening results were greater than 100 parts per million (ppm) in both of the samples. Field screening data tables are presented in Appendix D.

4.2.1.2 Groundwater in the Tank Socket

Volatile Organic Compounds (VOCs)

1,1,2,2-Tetrachloroethane was detected at a concentration of 1 microgram per liter (μg/L) in the groundwater sample collected from MW-125. This analyte is a common industrial solvent (Sax and Lewis, 1987).

Semi-Volatile Organic Compounds (SVOCs)

Fluorene, phenanthrene, pyrene, and chrysene were detected in concentrations ranging from 20 to 48 μg/L in the MW-125 groundwater sample. All are PAHs, and are constituents of heavy oils.

RCRA 8 Metals

No metals were present above detection limits in the MW-125 groundwater sample.

4.2.1.3 Shunt Piping

Total Petroleum Hydrocarbons (TPH)

Two subsurface soil samples were collected for TPH immunoassay field screening from P1. The samples were collected from 4 to 6 feet bgs, and 6 to 8 feet bgs. TPH screening results were used to determine which sample to send for lab analysis. Field screening data tables are presented in Appendix D.

TPH was not detected by laboratory analysis (Method 8015) in the soil probing sample (Table 4-3).

TABLE 4-3
TPH IN SUBSURFACE SOIL
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING NO.	DEPTH SAMPLED	CONCENTRATION (mg/kg)	FIELD EVENT	EXCEEDS GUIDELINE OF	
				2,500 mg/kg	5,000 mg/kg(1)
B-38	26-28	ND(2)	PCA	NA	No
B-38	32-34	ND(2)	PCA	NA	No
P-1	6-8	ND(2)	PCA	No	NA
SB-415	18-20	ND(3)	SI	NA	No
SB-416/(MW-416)	12-14	ND(3)	SI	No	NA
SB-416/(MW-416)	30-32	150(3)	SI	NA	No
SB-416/(MW-416)	34-36	2,100(3)	SI	NA	No
SB-417/(MW-417)	14-16	ND(3)	SI	NA	No
SB-417/(MW-417)	32-34	1,620(3)	SI	NA	No
SB-417/(MW-417)	38-40	600(3)	SI	NA	No
SB-418/(MW-418)	16-18	ND(3)	SI	NA	No
SB-418/(MW-418)	36-38	130(3)	SI	NA	No
SB-418/(MW-418)	42-44	160(3)	SI	NA	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
NA - Not Applicable
PCA - Preliminary Closure Assessment
SI - Site Investigation
(1) - Comparisons to Regulatory Standards and Guidelines are discussed in Section 4.6
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

MW-125 was installed in boring location B-38.

Analytical results of duplicate samples were averaged.

4.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION

The following section presents the findings of the SI field effort. Sampling and analysis focused on determining the extent of petroleum-impacted soils and groundwater. TPH results collected during the PCA will also be discussed here to present a comprehensive evaluation of TPH data.

Soil and groundwater samples were collected and analyzed for TPH by EPA Method 418.1. Results of TPH analyses in subsurface soils and groundwater are reported in Tables 4-3 and 4-4. Soil samples were collected for grainsize analysis, percent moisture, sediment oxygen demand (SOD) or modified biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), heterotrophic plate count, total phosphorus, and nitrate (Table 4-5). This group of soil sample analyses is termed "engineering parameters" for discussion purposes. Results of these analyses are reported here for informational purposes only. The data will be evaluated as part of the assessment of remedial technologies, presented under separate cover. Complete laboratory analytical results are presented in Appendix D.

4.3.1 Subsurface Soils

Petroleum-impacted subsurface soils, with concentrations of TPH exceeding the proposed 2,500 mg/kg guidance concentration were not identified at Tank 38, although soils impacted with NAPL were noted at Tank 38 during the SI. Figures 4-1 and 4-2 present a plan view and a cross-section of Tank 38.

The highest concentration of TPH (2100 mg/kg) was detected in a subsurface soil sample collected from MW-416, at 34 to 36 feet bgs. In November 1994, the water table was measured at 28.92 feet bgs in MW-125, which is located within the bedrock socket, approximately 5 feet from the tank. TPH was detected in soil samples collected from depths ranging from 30 feet to 44 feet bgs at MW-416, MW-417, and MW-418, each of which is located within the socket area of the tank. TPH is below laboratory detection limits in soil samples collected from B-38, as well as in samples collected from 9 intervals above 30 feet bgs in MW-416, MW-417, and MW-418. TPH was not identified by laboratory analyses of soils collected from 32 to 34 feet bgs at B-38, although the sample was visually petroleum-impacted with residual NAPL.

The TPH concentration in the soil sample collected from SB-415, located approximately 25 feet downgradient of Tank 38, was below laboratory detection limits.

TABLE 4-4
TPH IN GROUNDWATER
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Well No.	Well Screen Depth Interval (ft bgs)	TPH Concentration in Groundwater (mg/L)	TPH Concentration in Soil at Screen Interval (mg/kg)[1]	Groundwater Sample Date
MW-125	34-39	NA	ND[2]	November, 94
MW-416	33-38	12.2[3]	2,100[3]	December, 95
MW-417	34-39	24[3]	600[3]	December, 95
MW-418	37-42	1.6[3]	130[3]	December, 95
MW-418	37-42		160[3]	December, 95

Legend:

mg/L - milligram per liter
ft bgs - Feet Below Ground Surface
ND - Not Detected
NA - Not Analyzed for TPH
(1) - The soil sample interval is coincident with or overlaps the well screen interval.
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

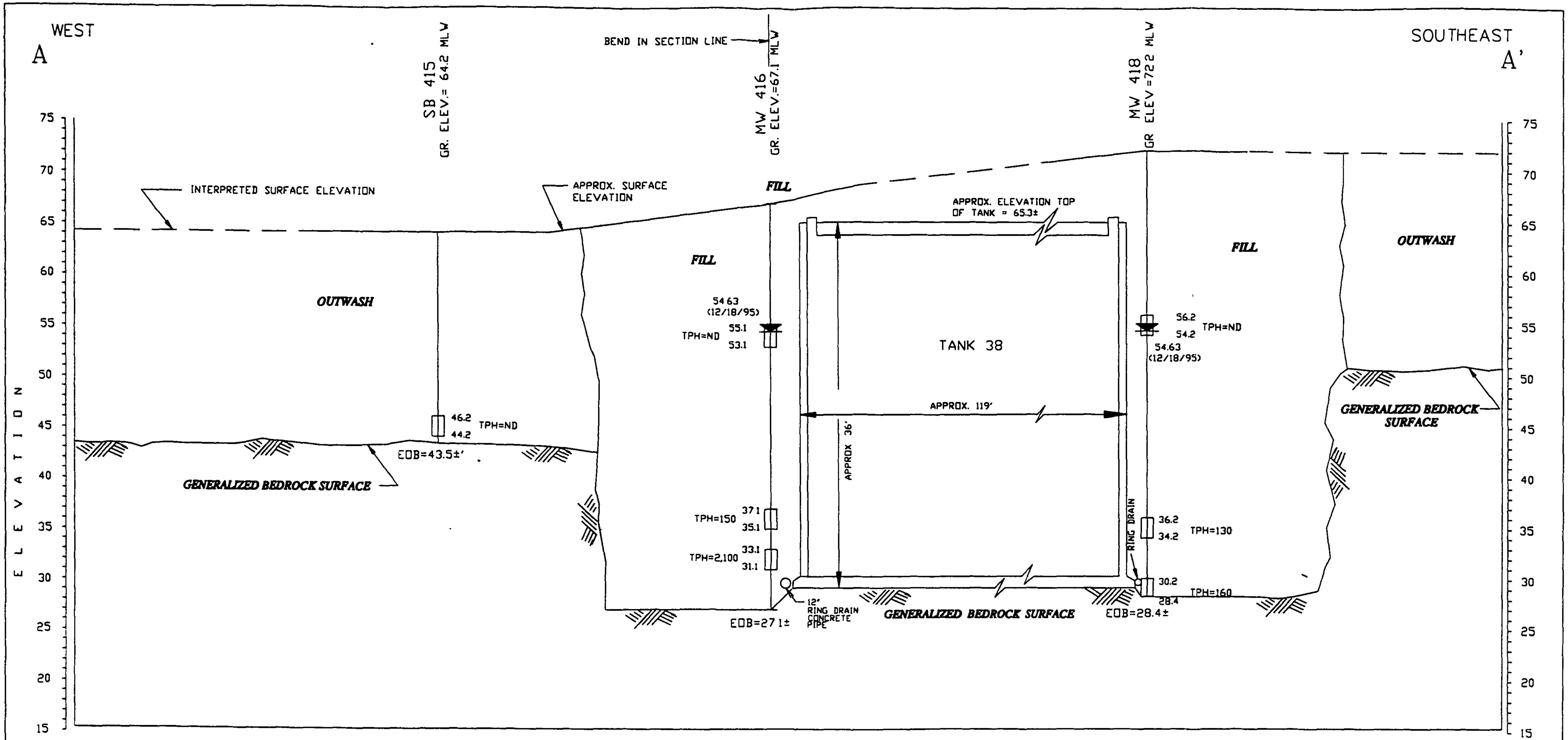
- MW-125 was installed in boring location B-38.
- Analytical results of duplicate samples were averaged.

TABLE 4-5
SUMMARY OF ENGINEERING PARAMETERS - POSITIVE DETECTS IN SUBSURFACE SOIL SAMPLES
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC-NEWPORT, RHODE ISLAND

Boring ID	Sample Depth (ft bgs)	SOD (mg/kg)	COD (mg/kg)	TOC (mg/kg)	Nitrate-Nitrite (as N)	Total Phosphorous (as P)	Heterotrophic Plate Count (cfu/g)	Percent Moisture	Grain Size
SB-416	22-24	NA	NA	NA	NA	NA	NA	14	Appendix D
SB-416	30-32	265	162	4,670	2.3	ND	30,000	NA	NA
SB-416	34-36	1,760	391	10,400	1.3	14.5	10,000	6.1(1)	Appendix D
SB-417	16-18	NA	NA	NA	NA	NA	NA	12.6	Appendix D
SB-417	32-34	1,340	313	5,970	1.7	7.6	70,000	NA	NA
SB-417	34-38	NA	NA	NA	NA	NA	NA	17.1	Appendix D

Legend:

SOD - Sediment Oxygen Demand (Modified Biochemical Oxygen Demand Method)
COD - Chemical Oxygen Demand
TOC - Total Organic Carbon
ft bgs - feet below ground surface
mg/kg - milligram per Kilogram reported on a dry weight basis
cfu/g - colony forming units/gram
ND - Not Detected
NA - Not Analyzed
(1) - Sample from 34-38



LEGEND

46.9 / 44.9 TPH=5.0 — SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

54.63 (12/18/95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN = 10 FT.

N O T E:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN

CROSS-SECTION A-A' - TANK 38

NETC-NEWPORT, RI

SITE INVESTIGATION REPORT - TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	22 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.:	D:\DWG\NETC\SI-38-48\XSECT38

FIGURE 4-2

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F

4.3.2 Groundwater

One groundwater sample round was conducted by B&R Environmental in November 1994 as part of the PCA, and one round was collected in December 1995 during the SI. TPH was present above detection limits in groundwater samples collected from the monitoring wells adjacent to Tank 38, which are screened at a depth corresponding to the design depth of the ring drain. TPH concentrations in groundwater range from a low of 1.6 mg/L in MW-418 to a high of 24.0 mg/L in MW-417.

Table 4-4 presents the results of groundwater TPH analyses during these investigations. A comparison of TPH concentrations in groundwater is made with a corresponding 2-foot split-barrel soil sample interval. No correlation exists between TPH concentrations in soil and TPH concentrations in groundwater.

Results of petroleum characterization by Method 8015 analyses indicated that TPH patterns at Tank Farm 4 were similar to those for bunker oil (HNUS, 1995a). The heavier oils such as No. 6 fuel oil are less soluble and will tend to migrate through the aquifer as free product (NAPL), but are relatively immobile due to high viscosity and low solubility.

4.3.3 Hydraulic Conductivity Measurements

Although hydraulic conductivity testing was not conducted at Tank 38, testing was conducted at Tank 45, Tank 48, and Tank 50 (during the SI conducted at Tank 50, Tank Farm 5, B&R Environmental, 1995b), as described in Section 3.3.2.

Interpretation of the data indicates that the insitu soils have a hydraulic conductivity between 1.4E-03 and 9.5E-04 centimeters per second (cm/sec), while the fill surrounding the tanks has a hydraulic conductivity between 6.66E-02 and 2.5E-03 cm/sec. The hydraulic conductivity of the bedrock was between 1.0E-03 and 1.2E-04 cm/sec (Table 3-1).

The hydraulic conductivity of the natural soils and bedrock surrounding higher conductivity fill materials may impede the flow of free product and groundwater from petroleum-impacted fill materials to bedrock and insitu soils downgradient of the tank. The degree of effectiveness of this partial barrier may vary locally, and further investigation would be required to determine their effectiveness in minimizing the migration of petroleum.

4.3.4 Saturated Thickness

The area of investigation is dominated by the presence of a large UST (36-feet high by 119-feet in diameter) and an excavation backfilled with material of widely varying porosity that extends approximately 16 feet below the original bedrock surface. The saturated thickness of the aquifer in the unconsolidated materials is therefore a function of the location of the tank socket.

Using December 1995 groundwater levels measured in MW-416, the depth to the water table is approximately 12.5 feet bgs. Based on an estimated socket depth of 40 feet, the saturated thickness of the aquifer within the socket is approximately 27.5 feet. From Boring SB-415, the depth to bedrock is approximately 20.7 feet bgs, therefore, the water table is approximately 11 feet above the bedrock surface within the socket (Figure 4-2). The saturated thickness outside the socket is approximately 11 feet.

4.3.5 Surface Soil

Two surficial soil samples were collected in an area overlying the tank and submitted for TPH analysis (Figure 4-1). The objective of these samples was to evaluate the presence of petroleum-impacted soils overlying the roof of Tank 38. The sample locations were selected to evaluate soils in areas of the tank that would be impacted in the event of an overfill at the tank. Samples were collected at the tank manway and vent. No overfills were documented at the tank.

Analytical results indicate a TPH concentration of 89 mg/kg at SS-02, collected 2 to 6 feet in front of the tank man-way. TPH was detected in sample SS-01 collected 2 to 6 feet from the tank vent at a concentration of 41 mg/kg. Analytical results are presented in Table 4-6.

4.4 VOLATILE ORGANIC COMPOUND MONITORING

Preliminary Closure Assessment

PCA laboratory results indicate that VOCs are not significant components of petroleum-impacted soils or groundwater (Table 4-2). An on-site source of VOCs that would result in a release to the ambient air has not been identified.

TABLE 4-6
TPH IN SURFACE SOIL
TANK 38, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

SAMPLE ID	DEPTH SAMPLED	CONCENTRATION (mg/kg)	EXCEEDS GUIDANCE OF 2,500 mg/kg (YES/NO)
TK38-SS-01	01-02	89(1)	No
TK38-SS-02	01-02	41(1)	No

Legend:

mg/kg - milligram per Kilogram
(1) - EPA Method 418.1

Site Investigation

During the soil sampling task of the SI, soil samples were field screened with a FID to evaluate the presence of VOCs. Ambient air screening with a PID was also conducted as part of routine health and safety monitoring to protect site workers.

Results from both investigations indicate that no VOCs were detected in the ambient air or in soils at Tank 38.

4.5 SURFACE WATER DRAINAGE

Runoff from Tank 38 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,500 feet to the west. Most rainwater infiltrates soil and permeable fill materials, and exits the site as groundwater.

4.6 COMPARISONS TO REGULATORY STANDARDS

Laboratory analytical results were evaluated with respect to one or more of the following regulatory standards:

- Rhode Island Department of Health Lead Poisoning Prevention Standard (150 mg/kg) (RIDOH, 1992).

- U.S. EPA "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (400 ppm) (EPA, 1994a).

- U.S. EPA "Drinking Water Regulations and Health Advisories" (Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs)) (EPA, 1994b).

- RIDEM "Rules and Regulations for Groundwater Quality" (Groundwater Quality Standards and Preventative Action Limits) (RIDEM, 1993b).

- "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA Groundwater Protection Standard) (EPA, 1991).

Regulatory standards have not been established for 2-butanone, bis(2-ethylhexyl)phthalate, fluorene, arsenic, barium, cadmium, and chromium in soil. Similarly, none have been established for 1,1,2,2-tetrachloroethane, fluorene, phenanthrene, or pyrene in groundwater.

Chrysene in the MW-125 groundwater sample was evaluated with respect to SDWA MCLs (U.S. EPA 1994b). The federal regulatory standard for this analyte in groundwater is 0.2 μg/L. Chrysene was detected at a concentration of 23 μg/L. This concentration exceeds the federal standard.

The groundwater at the site is not used for potable purposes, and as such, is not subject to the provisions of the Safe Water Drinking Act (SDWA). However, lacking appropriate and relevant regulatory requirements for this medium, the SDWA Maximum Contaminant Levels (MCLs) for chemicals detected in groundwater are used for comparison.

4.6.1 TPH Clean-up Levels

TPH clean-up levels are identified to develop remedies for protecting human health and the environment and to ensure that the selected remedial alternative will
objectives will be considered in developing clean-up levels
to select appropriate future actions at the tank farm. Th

- Protect human health from risks on site associated with ingestion of, inhalation of, and dermal contact with impacted soils.

- Protect human health and the environment by controlling any off-site migration of contaminated groundwater (although no significant migration has occurred)

RIDEM has established guidance concentrations of TPH in soils that specifically apply to using excavated soil as backfill material following UST removal. RIDEM generally establishes UST-related soil and groundwater clean-up criteria on a case-by-case basis considering potential off-site migration of impacted groundwater, and the presence of site-specific potential human and ecological receptors.

4.6.1.1 Exposure Routes

A significant objective of a clean-up level is to minimize the effects of chemicals to human and environmental receptors. Potential exposure routes of impacted soils to humans include ingestion, dermal contact, and inhalation of fugitive dust from surface soils. Because most impacted soils are located beneath a minimum of 30 feet of "unimpacted" soils, these exposure pathways do not present a significant risk to humans at the site surface.

Several exposure pathways that have been identified through pathway modeling (B&R Environmental, 1996) include dermal contact of impacted soils by a construction worker who may be exposed during excavation activities or ingestion of small quantities of soil by workers or trespassers.

Potential inhalation of VOCs is not considered an exposure pathway at the site. No VOCs were detected in ambient air during health and safety monitoring conducted during site investigation field work. Sampling and analysis of soils during the PCA confirmed the presence of only very low concentrations of VOCs in impacted site soils and groundwater.

Ingestion of groundwater is not considered a potential exposure pathway because local groundwater resources are classified as a type "GB" aquifer (Code of Rhode Island Rules Number 12-100-006, Section 9 and Appendix II), which is not suitable for drinking. Also, Tank Farm 4 is not located within a groundwater reservoir or groundwater recharge area (Code of Rhode Island Rules Number 12-100-006, Appendix III and IV) and no public or private water supply wells are located downgradient of the farm. The only potential pathway of human exposure to petroleum-impacted groundwater is through dermal contact at areas of groundwater discharge to surface water bodies. Runoff from Tank 38 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,500 feet to the west. Studies conducted during the Tank 50 SI have indicated that the mobility of the petroleum constituents in groundwater is minimal, even in areas where TPH in soil exceeds 10,000 mg/kg (B&R Environmental, 1995b). Therefore, the potential for human exposure to impacted groundwater is considered low.

Pathway modeling was conducted to identify potential exposures of ecological receptors at Tank 50, Tank Farm 5. The results of the modeling were presented in the Technology Screening Evaluation (B&R Environmental, 1996). The model can generally be applied to Tank 38, because tank construction methods are similar, and land development in the downgradient direction from Tank 38 is similar to areas downgradient of Tank 50. Results of the modeling indicated that no complete pathways exist for migration of impacted media to ecological receptors.

4.6.1.2 Proposed Clean-up Levels

RIDEM has a policy of establishing site-specific TPH clean-up levels. TPH concentrations in soil of 2,500 mg/kg and 5,000 mg/kg will be proposed by the Navy as clean-up levels at Tank 38. These concentrations are considered conservative and were adopted as soil clean-up standards by Massachusetts and published as part of the MCP in November, 1993 (MADEP, 1993) and are not legally binding in Rhode Island.

These soil standards were established based on the characterization of risk posed by petroleum-impacted disposal sites. The MCP and various guidance and policy documents issued by the Massachusetts Department of Environmental Protection (MADEP) describes the documentation of site risk. Both groundwater usage (310 CMR:40.0931 and 40.0932) and accessibility to soil (310 CMR 40.0931 and 40.0933) are considered in the site risk characterization.

The proposed clean-up level of 2,500 mg/kg TPH in soil considers that soils may be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(b)), and are "potentially accessible," described as being "located at a depth of 3 - 15 feet below the surface..." (310 CMR 40.0933(4)(c)).

The proposed clean-up level of 5,000 mg/kg TPH in soil considers that soils may also be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(a)), and are "isolated," described as being "located at a depth greater than 15 feet below the surface..." (310 CMR 40.0933(4)(c)). The applicable sections of the MCP are included in Appendix E.

4.7 FUTURE ACTIONS

This section presents recommended future actions at Tank 38. Two actions are discussed: source control and institutional controls.

4.7.1 <u>Source Control</u>

Tank contents removal and cleaning is scheduled for the summer of 1996. Product will be removed and the tank will be cleaned and closed. The tank will be inspected and closed following approval by RIDEM.

4.7.2 <u>Institutional Controls</u>

General response actions describe those actions that will satisfy the remedial objectives. General response actions may include institutional controls, containment, treatment, removal and disposal, or a combination of these. Several options are available to address impacted soil at Tank Farm 4;

however, the general response action that appears most appropriate for implementation at Tank 38 is institutional controls.

Institutional controls include options such as deed restrictions and monitoring. Deed restrictions, land use restrictions, or other policies or rules prevent the exposure of workers and nearby residents to impacted media. These controls are intended to limit future placement of drinking water wells, construction or demolition activities, and excavation activities.

Monitoring consists of sampling and laboratory analyses of groundwater to detect petroleum migration and groundwater movement.

Institutional controls and groundwater monitoring may be effective at preventing exposure to impacted media present in the vicinity of Tank 51. Institutional controls would prevent the installation of water supply wells, eliminating potential exposure resulting from the use of groundwater.

Institutional controls or deed restrictions can preclude excavation in the vicinity of the tank without proper engineering controls for the protection of site workers. Engineering controls include fugitive dust emissions management, and other site safety precautions such as the implementation of a health and safety plan, and use of personal protection equipment (PPE).

5.0 TANK 42 SITE INVESTIGATION

Section 5.0 summarizes field activities conducted to evaluate the nature and extent of petroleum-impacted soils and groundwater, and effects to human health and the environment at Tank 42. The PCA evaluated the impacts to soil and groundwater of past petroleum storage and handling practices at each of the Tank Farm 4 and 5 USTs, including Tank 42. Results of the PCA indicated the need for conducting an SI at Tank 42.

<u>Preliminary Closure Assessment</u>

Specific soil and groundwater sampling methods and soil boring and monitoring well construction techniques are described in detail in the final Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5, dated September 1994 (HNUS, 1994). Additional RIDEM comments, which addressed initiating soil sampling at the water table, and containerizing all IDW were conveyed to the B&R Project Manager and the NETC representative (personal communication).

GPR and utility location surveys were conducted by a subcontractor to B&R Environmental to identify the UST edges and associated piping to facilitate borehole placement.

The PCA field investigation was conducted by B&R Environmental from October to December 1994. The PCA involved advancing one soil boring (B-42), and subsequently installing a groundwater monitoring well, MW-123, on the hydraulically downgradient side of Tank 42 (Figure 5-1). The objective of the study was to conduct preliminary investigations for the presence of petroleum that may have accumulated in the ring drain.

Soil sampling was initiated at 26 feet bgs, the estimated depth of the water table in MW-123, and continued to the end of the boring, approximately 39 feet bgs. Soil cuttings and air samples at each borehole were monitored with photo and flame ionization detectors (PIDs and FIDs). Visual and olfactory evidence of the presence of petroleum was noted on boring logs (Appendix B).

Selected soil samples were screened with an Ensys immunoassay kit for the presence of TPH. The sample that exhibited the highest concentration of petroleum, as determined by immunoassay results, was generally selected for laboratory analysis. Soil samples selected for laboratory analysis were analyzed by EPA methods for volatile and semi-volatile organic compounds, TPH, and the eight RCRA metals. Groundwater samples were analyzed by EPA methods for volatile and semi-volatile organic

LEGEND

38-SB415 — SOIL BORING LOCATION WITH IDENTIFIER

TF4-MW125 — MONITORING WELL LOCATION WITH IDENTIFIER

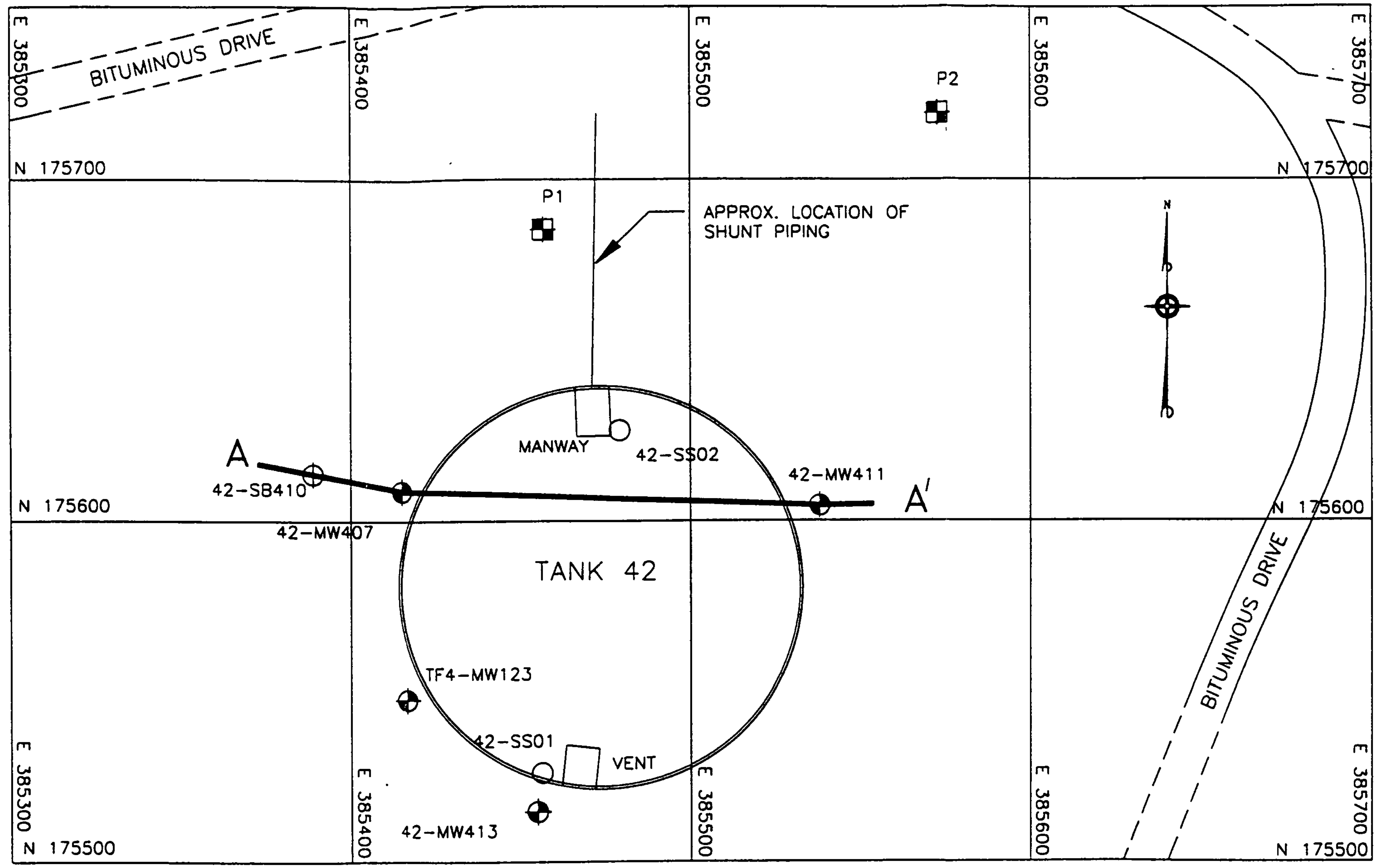
42-SS02 — SURFACE SOIL SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.

2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.

3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

CROSS-SECTION LOCUS MAP – TANK 42

NETC-NEWPORT, RI

SITE INVESTIGATION REPORT – TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J.B. HOLDEN	DATE:	16 FEB 96
SCALE:	1" = 40'	FILE NO.: D:\DWG\NETC\SI-38-48\FIG_5-1	

FIGURE 5-1

Brown & Root Environmental

A Division of Halliburton NUS Corporation

55 Jonspin Road Wilmington, MA 01887

(508)658-7899

W5296104F

compounds, and the eight RCRA metals. The objective of the soil boring and groundwater monitoring well is summarized in Table 5-1.

Two soil probings, P1-42 and P2-42, were advanced on the hydraulically downgradient side of the shunt piping run at Tank 42 to evaluate the presence of petroleum-impacted soil. The probings were performed using a combination of standard solid-stem auger methods, advancing a 2.5-inch diameter drive point, and advancing an open hole with a split-spoon sampler. Two split-spoon samples were then obtained from 4 to 6 and 6 to 8 feet bgs. A review of the best available data determined that the piping lay no deeper than 5 feet bgs. Later work and investigations at Tank Farm 5 indicated that the piping is located 6 to 8 feet bgs (Jalkut, 1995b). The soil samples were screened using the Ensys Petro Risc immunoassay kit for the presence of petroleum hydrocarbons. The sample exhibiting the highest concentration of petroleum in each probing was submitted for laboratory analysis. Probing field logs are presented in Appendix B.

<u>Site Investigation</u>

The SI was conducted by B&R Environmental between November 1995 and January 1996, and focused on delineating the extent of TPH in soil and groundwater. During the SI field effort four soil borings were advanced and two surface soil samples were collected (Figure 5-1). Of the four soil borings, three, SB-407, SB-411, and SB-413, were advanced through the unconsolidated overburden, and completed as groundwater monitoring wells, MW-407, MW-411, and MW-413.

In MW-407, split-barrel soil sampling was initiated at the ground surface and continued to refusal in order to define the vertical extent of petroleum-impacted soils. In the remainder of the borings, samples were collected at standard intervals (5-foot intervals) from ground surface to the water table and continuously from the water table to the end of the boring at refusal.

One boring, SB-410, was advanced to investigate potential migration of petroleum in the unconsolidated overburden downgradient of the tank outside the tank socket. Soil samples were collected and the boring was backfilled. Soil boring and well construction logs are presented in Appendix B and C, respectively. Analytical data is reported in Appendix D. The objective of the soil boring and groundwater monitoring well is summarized in Table 5-1.

5.1 ANALYTICAL METHODS

The following section summarizes analytical methods utilized during the PCA and the SI.

TABLE 5-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
B-42/(MW-123)	PCA	Downgradient to Tank 42; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples.
SB-407/(MW-407)	SI	Downgradient of Tank 42; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
SB-410	SI	Downgradient of Tank 42; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
SB-411/(MW-411)	SI	Upgradient of Tank 42; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
SB-413/(MW-413)	SI	Crossgradient of Tank 42; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples.
P-1	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
P-2	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
SS-01	SI	Top of Tank 42 roof - south side, near former location of small manway.	Provide data on presence of TPH impacted soils above the tank lid.	NA	NA
SS-02	SI	Top of Tank 42 roof - north side, near large manway with door.	Provide data on presence of TPH impacted soils above the tank roof.	NA	NA

Legend:

PCA - Preliminary Closure Assessment
SI - Site Investigation
NA - Not Applicable

EPA-approved laboratory methods were used to evaluate soil and groundwater samples at the site. Detailed descriptions of specific field procedures and analytical methods are presented in the "Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5", prepared by B&R Environmental (as Halliburton NUS) dated September 1994, with Addendum 1 (HNUS, 1995c) and Addendum 2 (HNUS 1995e).

Throughout each investigation, soil and groundwater samples were collected and analyzed according to Naval Facilities Engineering Service Center (NFESC) requirements. All environmental samples collected as part of these investigations, including QC samples, were stored and shipped in accordance with chain-of-custody procedures outlined in the project-specific Quality Assurance/Quality Control Plan prepared as part of the Work Plan.

5.1.1 Field Screening

Preliminary Closure Assessment

Because Tank 42 had been used to store virgin No. 6 fuel oil and possibly No. 2 fuel oil, environmental media were analyzed for parameters typically associated with petroleum components. During the PCA investigation, soil samples were visually inspected for the presence of petroleum, screened with PIDs and FIDs, and an Ensys Petro Risc immunoassay kit. Generally, PIDs were used for health and safety screening for VOCs, while FIDs were used for soil screening for VOCs and SVOCs. Visually impacted soils were not Ensys screened. Results of Ensys TPH screening were confirmed by laboratory analysis.

Site Investigation

During the SI, soil samples were visually inspected for the presence of petroleum and screened with FIDs. Results of TPH screening were confirmed by laboratory analysis.

5.1.2 Laboratory Analysis

Preliminary Closure Assessment

During the PCA, sample analyses were conducted by Ceimic Laboratories of Narragansett, Rhode Island. Ceimic is a NFESC-approved laboratory.

EPA-approved analytical methods were used for laboratory analyses. Soil samples were analyzed for TCL volatile organic compounds (Method SW-846 8240); TCL semi-volatile organic compounds (Method SW-846 8270); RCRA metals (Method SOW ILMO 3.0) to evaluate potential impacts to soil from sludge pits reported to exist on site. TPH extractables (Method SW-846 8015) were analyzed to evaluate potential impacts of releases of petroleum from USTs to soils. Groundwater samples were not analyzed for TPH, but otherwise were analyzed for the same parameters.

Site Investigation

Samples collected and analyzed during the SI were analyzed for TPH (Method SW-846 418.1). Soil samples were also analyzed for several engineering parameters that will be used to evaluate potential remedial alternatives. Parameters and analytical methods include: grainsize (ASTM D421/422), moisture content (ASTM 2216), heterotrophic plate count (SM 9215 modified), sediment oxygen demand (modified BOD Method SM 5210B), chemical oxygen demand (E 410.1 modified), total phosphorus (E 365.4 modified), nitrate (SW 9200), and total organic carbon (TOC-SW/9060). TPH and most engineering analyses were conducted by Ceimic, heterotrophic plate count by Lancaster Laboratories, and grainsize by Geotechnics. Laboratory analytical results are presented in Appendix D.

TPH extractables were analyzed during the PCA using Method 8015 to identify a petroleum fingerprint. During the SI, TPH was analyzed using Method 418.1 because the Rhode Island action level guidance is based on Method 418.1. Analysis conducted during the PCA indicated minimal concentrations of VOCs in soil and groundwater. Soils present within the investigation areas are organic-poor mineral soils. Method 418.1 analyzes the total number of carbon-hydrogen bonds in a sample, while Method 8015 is specific to petroleum hydrocarbons. The low organic characteristics of a mineral soil minimizes the potential for interference caused by elevated levels of organic compounds when using Method 418.1. Data collected using Method 418.1 is therefore considered roughly comparable to data analyzed using Method 8015.

5.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT

MW-123 was installed as part of the PCA field investigation and is located hydraulically downgradient of Tank 42, approximately 5 feet from its perimeter (Figure 5-1). The MW-123 well screen was set 33 to 38 feet bgs to correspond with the estimated depth of the ring drain.

The upper 26 feet of the boring was not examined. Soil sampling was initiated at 26 feet below ground surface based on historical data indicating that the water table was approximately 26 feet bgs. It was presumed that petroleum releases above the water table would migrate vertically downward and be detected in soil and possibly groundwater. Soil sampling was continuous from 26.00 feet bgs to refusal at 38.75 feet bgs.

The fill primarily consists of sandy gravel with small percentages of silt and sand. Coarse gravel with sand from 36.00 to 38.75 feet bgs was heavily impacted with petroleum staining and residual NAPL.

Tan to grey metamorphic rock with an oxidized layer was encountered at refusal at approximately 38.75 feet bgs. Due to the highly altered condition of the rock, identification of the parent rock type was difficult.

On November 29, 1994, the depth to the water table as measured in MW-123 was 31.42 feet bgs. Seasonal and precipitation effects on groundwater levels have not been evaluated at the site.

5.2.1 Analytical Data Summary

The PCA subsurface investigation included soil sampling during the advancement of MW-123 (B-42) and subsequent groundwater sample collection and analysis. Investigations conducted during the PCA focused on determining the nature of impacted soil and groundwater.

During the PCA, two subsurface soil samples (B423234 and B423638) were selected for laboratory analysis from B-42 (MW-123), located near Tank 42. The samples were collected from depths of 32 to 34 feet bgs and 36 to 38 feet bgs, and consisted of gravel with variable amounts of sand and a trace percentage of silt. Soils were impacted by petroleum from 36 feet to approximately 38 feet bgs. Following standard well development and well purging procedures, a groundwater sample was collected from the midpoint of the well screen, at approximately 36 feet bgs. Immiscible oil droplets were observed during groundwater sample collection.

Two subsurface soil samples were selected for analysis from the soil probings downgradient of the shunt piping for Tank 42. These samples were collected from depths of 4 to 6 feet bgs (samples P1-42-0406 and P2-42-0406). Samples P1 and P2 consisted of silty gravelly sand.

Positive soil and groundwater analytical results are reported in Table 5-2. Complete laboratory analytical results are reported in Appendix D.

TABLE 5-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-42	32-34	Bis(2-ethylhexyl)phthalate	93 μg/kg	None	N/A
Soil	B-42	32-34	Arsenic	31.5 mg/kg	None	N/A
Soil	B-42	32-34	Barium	6.0 mg/kg	None	N/A
Soil	B-42	32-34	Cadmium	4.7 mg/kg	None	N/A
Soil	B-42	32-34	Chromium	15.9 mg/kg	None	N/A
Soil	B-42	32-34	Lead	10.6 mg/kg	150 ppm (4) 400 ppm (5)	No
Soil	B-42	36-38	Pyrene	440 μg/kg	None	N/A
Soil	B-42	36-38	Arsenic	11.4 mg/kg	None	N/A
Soil	B-42	36-38	Barium	6.4 mg/kg	None	N/A
Soil	B-42	36-38	Cadmium	2.8 mg/kg	None	N/A
Soil	B-42	36-38	Chromium	16.0 mg/kg	None	N/A
Soil	B-42	36-38	Lead	6.6 mg/kg	150 ppm (4) 400 ppm (5)	No
Groundwater	MW-123	33-38	Arsenic	33.0 μg/L	50 μg/L (2), (3), (6)	No
Groundwater	MW-123	33-38	Chromium	25.8 μg/L	100 μg/L (2) & (3) 50 μg/L (5)	No
Groundwater	MW-123	33-38	Lead	16.0 μg/L	15 μg/L (2) & (3) 50 μg/L (6)	Yes (2) & (3) No (6)

TABLE 5-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 2

Legend:

ppm	-	parts per million
µg/L	-	micrograms per liter
mg/kg	-	milligrams per kilogram
µg/kg	-	micrograms per kilogram
N/A	-	Not Applicable

Notes:

(1) Comparisons to Regulatory Standards and Guidelines are discussed in Section 5.6.

(2) U.S. EPA Drinking Water Regulations and Health Advisories, EPA 822-R-94-001, May 1994.

(3) State of Rhode Island Department of Environmental Management, Rules No. 12-100-006, Rule and Regulations for Groundwater Quality, Section 10, July 1993.

(4) Rhode Island Department of Health - Environmental Lead Program, [R23-24.6-PB], Rules and Regulations for Lead Poisoning Prevention, February 1992 (with amendments).

(5) OSWER Directive 9355.4-12- Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.

(6) 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart F, Sections 264.92 - 264.94, July 1991.

- MW-123 was installed in boring location B-42.
- Analytical results of duplicate samples were averaged.

5.2.1.1 Subsurface Soils in the Tank Socket

Volatile Organic Compounds (VOCs)

No volatile organic compounds were present above detection limits in subsurface soil samples B423234 or B423638.

Semi-Volatile Organic Compounds (SVOCs)

Bis(2-ethylhexyl)phthalate (BEHP) was found in sample B423234, and pyrene was detected in sample B423638, at concentrations of 93 micrograms per kilogram (μg/kg) and 440 μg/kg, respectively. Phthalates are typically used as plasticizers in the manufacturing of PVC and other plastics (Howard, 1989; Sittig, 1981), including plastics used in analytical laboratories. Pyrene is a polynuclear aromatic hydrocarbon (PAH), and is a constituent of fuel oils (Dragun, 1988).

RCRA 8 Metals

Arsenic, barium, cadmium, chromium, and lead were detected in both subsurface soil samples collected from B42. Sample concentrations ranging from 2.8 milligrams per kilogram (mg/kg) to 31.5 mg/kg were reported. These metals are constituents of naturally occurring soils, however, the source of these analytes has not been determined.

Total Petroleum Hydrocarbons (TPH)

TPH was detected in laboratory analysis at a concentration of 5,700 mg/kg in sample B423638, and the pattern was identified as bunker oil. TPH was below detection limits in subsurface soil sample B423234.

Subsurface soil sample B422628 was field screened for TPH using an immunoassay method. The sample was collected from 26 to 28 feet bgs. The sample concentration was less than 100 ppm. Field screening data tables are presented in Appendix D.

5.2.1.2 Groundwater in the Tank Socket

Volatile Organic Compounds (VOCs)

No analytes were present above detection limits in the groundwater sample collected from MW-123.

Semi-Volatile Organic Compounds (SVOCs)

No analytes were present above detection limits in the groundwater sample collected from MW-123.

RCRA 8 Metals

Arsenic, chromium, and lead were detected in the groundwater sample collected from MW-123. Metal concentrations ranged from 16 μg/L to 33 μg/L. The source of these analytes may be a result of elevated turbidity in the groundwater sample. Metals typically are adsorbed onto silt and clay sized suspended particulates (Puls and Powell, 1992). These particulates are usually removed from formation materials in the vicinity of the well by developing the well.

The migration of silt and clay into a well is further minimized by a properly sized filter pack and well screen. At the direction of RIDEM, a 0.020 inch slot size screen section was installed in wells located within zones containing NAPL. This size screen aperture requires a larger sized filter pack, which is too large to retain the high silt and clay content of the fill materials in which the well is screened. The finer formation materials will continue to enter the well screen. The purpose of installing a relatively large screen aperture was to ensure that NAPL could enter the well so that the presence of NAPL could be evaluated. The 0.020 inch screen aperture size does allow the entry of NAPL into wells at the site.

5.2.1.3 Shunt Piping

Total Petroleum Hydrocarbons (TPH)

Two subsurface soil samples were selected for TPH immunoassay field screening from each soil probe. The samples were collected from 4 to 6 feet bgs, and 6 to 8 feet bgs. TPH screening results were used to determine which samples to send for laboratory analysis. Field screening data tables are presented in Appendix D.

TPH was not detected by laboratory analysis (Method 8015) in the soil probing samples (Table 5-3).

5.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION

The following section presents the findings of the SI field effort. Sampling and analysis focused on determining the extent of petroleum-impacted soils and groundwater. TPH results collected during the PCA will also be discussed here to present a comprehensive evaluation of TPH data.

Soil and groundwater samples were collected and analyzed for TPH by EPA Method 418.1. Results of TPH analyses in subsurface soils and groundwater are reported in Tables 5-3 and 5-4. Soil samples were collected for grainsize analysis, percent moisture, sediment oxygen demand (SOD) or modified biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), heterotrophic plate count, total phosphorus, and nitrate (Table 5-5). This group of soil sample analyses is termed "engineering parameters" for discussion purposes. Results of these analyses are reported here for informational purposes only. The data will be evaluated as part of the assessment of remedial technologies, presented under separate cover. Complete laboratory analytical results are presented in Appendix D.

5.3.1 Subsurface Soils

Initial subsurface investigations conducted during the PCA at Tank 42 (MW-123) indicated the presence of petroleum-impacted soils (maximum concentrations of 5,700 mg/kg, Table 5-3) within the socket at the downgradient edge of the Tank (Figure 5-1). NAPL was noted at the 36 to 38 foot bgs interval in MW-123. Soils consisted of gravel with variable amounts of sand and a trace percentage of silt.

TPH is below laboratory detection limits in soil samples collected from a corresponding depth below ground surface at MW-413 located within the tank socket area.

TPH is below laboratory detection limits in soil samples collected from SB-410, located approximately 27 feet downgradient of Tank 42. Boring logs are included in Appendix B, and analytical data are included in Appendix D.

The TPH pattern identified by laboratory analyses of soils collected at Tank 42 during the PCA report was bunker oil. Personal communications have indicated that bunker oil and possibly No. 2 fuel oil were stored at Tank Farm 4 (Martin, 1995). Most laboratory results indicated the presence of heavy

TABLE 5-3
TPH IN SUBSURFACE SOIL
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING NO.	DEPTH SAMPLED	CONCENTRATION (mg/kg)	FIELD EVENT	EXCEEDS GUIDELINE OF[1]	
				2,500 mg/kg	5,000 mg/kg
B-42/(MW-123)	36-38	5,700 (Bunker oil)[2]	PCA	Yes	Yes
P-1	4-6	ND[2]	PCA	No	No
P-2	4-6	ND[2]	PCA	No	No
SB-407/(MW-407)	30-32	220[3]	SI	No	No
SB-407/(MW-407)	38-40	4,900[3]	SI	Yes	No
SB-410	14-16	ND[3]	SI	No	No
SB-411/(MW-411)	30-32	3,900[3]	SI	Yes	No
SB-411/(MW-411)	39-41	1,800[3]	SI	No	No
SB-413/(MW-413)	30-32	ND[3]	SI	No	No
SB-413/(MW-413)	35-37	ND[3]	SI	No	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
PCA - Preliminary Closure Assessment
SI - Site Investigation
(1) - Comparison to Regulatory Standards and Guidelines are discussed in Section 5.6
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

Guideline is 2,500 mg/kg for depths 3-15 ft, 5,000 mg/kg for depths greater than 15 ft.

MW-123 was installed in boring location B-42.

Analytical results of duplicate samples were averaged.

TABLE 5-4
TPH IN GROUNDWATER
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Well No.	Well Screen Depth Interval (ft bgs)	TPH Concentration in Groundwater (mg/L)	TPH Concentration in Soil at Screen Interval (mg/kg)[1]	Groundwater Sample Date
MW-123	33-38	NA	5,700[2]	11/1994
MW-407	33-38	10[3]	4,900[3]	1/1996
MW-411	33-38	1.3[3]	1,800[3]	1/1996
MW-413	31-36	ND[3]	ND[3]	1/1996

Legend:

mg/L - milligram per liter
ft bgs - Feet Below Ground Surface
NA - Not Analyzed for TPH
ND - Not Detected
(1) - The soil sample interval is coincident with or overlaps the well screen interval.
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

- MW-123 was installed in boring location B-42.

  Analytical results of duplicate samples were averaged.

TABLE 5-5
SUMMARY OF ENGINEERING PARAMETERS - POSITIVE DETECTS IN SUBSURFACE SOIL SAMPLES
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC-NEWPORT, RHODE ISLAND

Boring ID	Sample Depth (ft bgs)	SOD (mg/kg)	COD (mg/kg)	TOC (mg/kg)	Nitrate-Nitrite (as N)	Total Phosphorus (as P)	Heterotrophic Plate Count (cfu/g)	Percent Moisture[1]	Grain Size
SB-407	28-30	NA	NA	NA	NA	NA	NA	8.9	Appendix D
SB-407	38-40	1,540	311	9,660	2.1	6.9	6,000	13.4	Appendix D
SB-407	39-41	NA	NA	NA	NA	NA	7,000	NA	NA
SB-411	35-37	NA	NA	NA	NA	NA	NA	9.1	Appendix D
SB-411	39-41	ND	ND	4,070	1.3	849	3,000	9.4	Appendix D
SB-413	35-37	ND	1,400	1,330	ND	ND	NA	NA	NA

Legend:

SOD - Sediment Oxygen Demand (Modified Biochemical Oxygen Demand Method)
COD - Chemical Oxygen Demand
TOC - Total Organic Carbon
ft bgs - feet below ground surface
mg/kg - milligram per Kilogram reported on a dry weight basis
cfu/g - colony forming units/gram
ND - Not Detected
NA - Not Analyzed
(1) - Groundwater was being pumped from ring drain during sample collection

oils in soil samples, including bunker oil. Mr. Henry Liebowitz (Ceimic) indicated that weathered bunker oil and No. 6 fuel oil often cannot be differentiated (Martin, 1995b).

5.3.2 Groundwater

One groundwater sample round was conducted by B&R Environmental in November 1994 as part of the PCA, and one round was conducted in January 1996 during the SI. TPH was detected above detection limits in groundwater samples collected from monitoring wells adjacent to Tank 42, which are screened at a depth corresponding to the design depth of the ring drain. The highest concentration of TPH in groundwater at Tank 42 was detected in MW-407 at 10 mg/kg. This indicates that groundwater is not a significant transport mechanism for heavy fuel oil at Tank 42.

Table 5-3 presents the results of groundwater TPH analyses during these investigations. A comparison of TPH concentrations in groundwater is made with a corresponding 2-foot split-barrel soil sample interval. A strong correlation does not exist between TPH concentrations in soil and TPH concentrations in groundwater.

The groundwater sample collected from the other ring drain well (MW-413) at Tank 42 exhibits TPH concentrations below the detection limit of 1 mg/L TPH, confirming that groundwater is not a significant migration pathway for petroleum compounds released from the tank.

5.3.3 Hydraulic Conductivity Measurements

Although hydraulic conductivity testing was not conducted at Tank 42, testing was conducted at Tank 45, Tank 48, and Tank 50 (during the SI conducted at Tank 50, Tank Farm 5, B&R Environmental, 1995b), as described in Section 3.3.2.

Interpretation of the data indicates that the insitu soils have a hydraulic conductivity between 1.4E-03 and 9.5E-04 centimeters per second (cm/sec), while the fill surrounding the tanks has a hydraulic conductivity between 6.66E-02 and 2.5E-03 cm/sec. The hydraulic conductivity of the bedrock was between 1.0E-03 and 1.2E-04 cm/sec (Table 3-1).

The hydraulic conductivity of the bedrock and natural soils surrounding higher conductivity fill materials may impede the flow of free product and groundwater from petroleum-impacted fill materials to bedrock and insitu soils downgradient of the tank. The degree of effectiveness of this partial barrier may vary locally, and further investigation would be required to determine their role.

5.3.4 Saturated Thickness

The area of investigation is dominated by the presence of the large UST (36-feet high by 119-feet in diameter) and an excavation backfilled with material of widely varying porosity that extends approximately 16 feet below the original bedrock surface. The saturated thickness of the aquifer in the unconsolidated materials is therefore a function of the location of the tank socket.

Using December 1995 groundwater levels measured in MW-407, the depth to the water table is approximately 28 feet bgs. Based on an estimated socket depth of 40 feet, the saturated thickness of the aquifer within the socket is approximately 12 feet. From Boring SB-410, the depth to bedrock is approximately 22 feet bgs, therefore, the water table is approximately 4 feet below the bedrock surface outside the tank socket (Figure 5-2).

5.3.5 Surface Soil

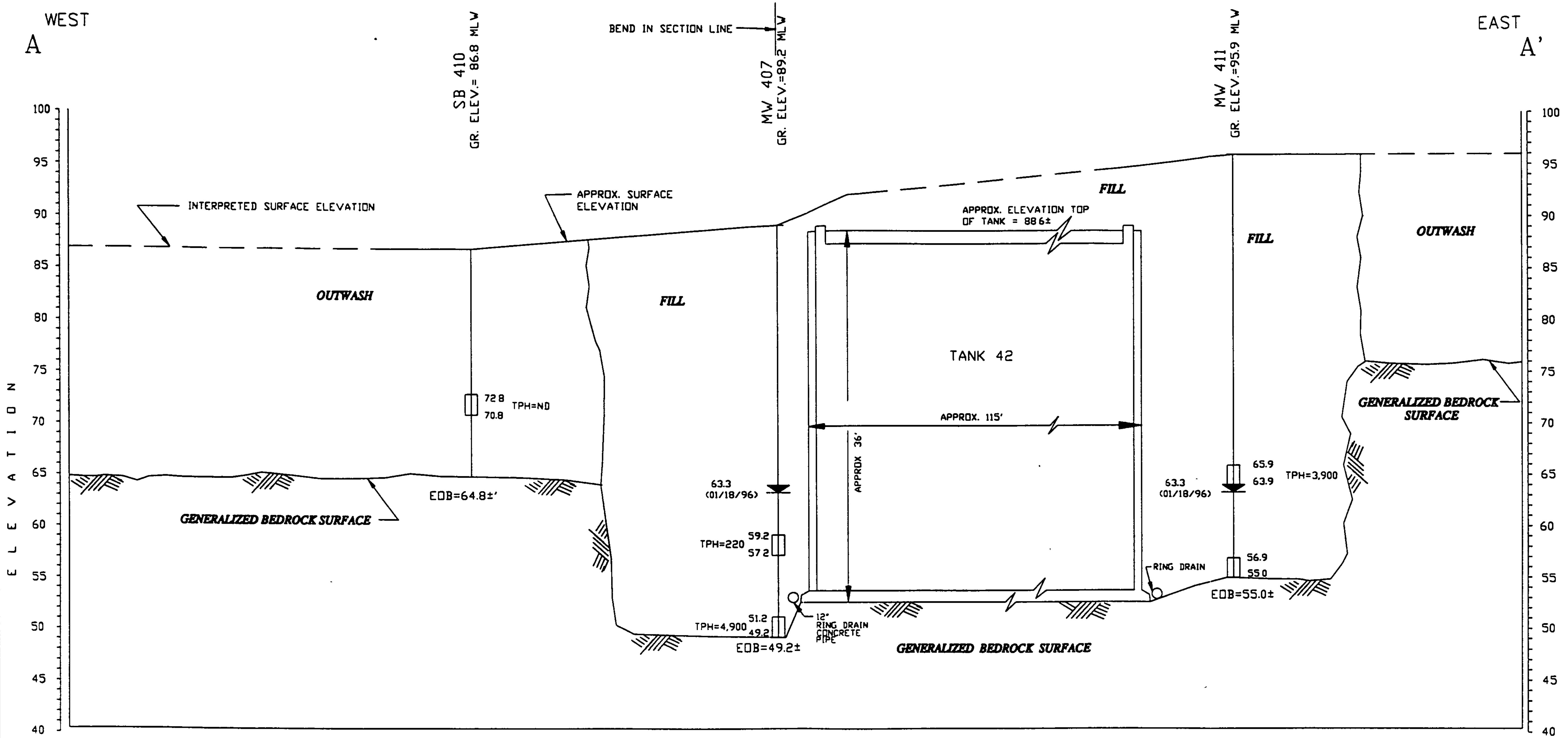
Two surficial soil samples were collected in an area overlying the tank and submitted for TPH analysis (Figure 5-1). The sampling objective was to evaluate the presence of petroleum-impacted soils overlying the roof of Tank 42. The sample locations were selected to evaluate soils in areas of the tank that would be impacted in the event of an overfill. No overfills were documented at the tank.

Analytical results indicate TPH concentrations below laboratory detection limits at SS-02, collected 2 to 6 feet in front of the tank man-way. No TPH was detected in sample SS-01 collected 2 to 6 feet from the vent. Analytical results are presented in Table 5-6.

5.4 VOLATILE ORGANIC COMPOUND MONITORING

Preliminary Closure Assessment

PCA laboratory results indicate that VOCs are not significant components of petroleum-impacted soils or groundwater (Table 5-2). An on-site source of VOCs that would result in a release to the ambient air has not been identified.



LEGEND

46.9 TPH=5.0 44.9 SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

63.3 (01/18/96) WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

NOTE:

1) JAN 1996, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN SOIL

CROSS-SECTION A-A' - TANK 42

NETC-NEWPORT, RI

SITE INVESTIGATION REPORT - TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.:	D:\DWG\NETC\SI-38-48\XSECT42

FIGURE 5-2

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

TABLE 5-6
TPH IN SURFACE SOIL
TANK 42, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

SAMPLE ID	DEPTH SAMPLED	CONCENTRATION (mg/kg)	EXCEEDS GUIDANCE OF 2,500 mg/kg (YES/NO)
TK42-SS-01	01-02	ND(1)	No
TK42-SS-02	01-02	ND(1)	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
(1) - EPA Method 418.1

Site Investigation

During the soil sampling task of the SI, soil samples were field screened with a FID to evaluate the presence of VOCs. Ambient air screening with a PID was also conducted as part of routine health and safety monitoring to protect site workers.

Results from both investigations indicate that no VOCs were detected in the ambient air or in soils at Tank 42.

5.5 SURFACE WATER DRAINAGE

Runoff from Tank 42 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,830 feet to the west. Most rainwater infiltrates soil and permeable fill materials, and exits the site as groundwater.

5.6 COMPARISONS TO REGULATORY STANDARDS

Laboratory analytical results were evaluated with respect to one or more of the following regulatory standards:

- Rhode Island Department of Health Lead Poisoning Prevention Standard (150 mg/kg) (RIDOH, 1992).
- U.S. EPA "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (400 ppm) (EPA, 1994a).
- U.S. EPA "Drinking Water Regulations and Health Advisories" (Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs)) (EPA, 1994b).
- RIDEM "Rules and Regulations for Groundwater Quality" (Groundwater Quality Standards and Preventative Action Limits) (RIDEM, 1993b).
- "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA Groundwater Protection Standard) (EPA, 1991).

Regulatory standards have not been established for bis(2-ethylhexyl)phthalate or pyrene in soil. Similarly, there are no standards for arsenic, barium, cadmium, and chromium in soil.

The Rhode Island Department of Health "lead-free" standard (1992) for soil was used to evaluate lead in subsurface soil samples B423234 and B423638. This standard, 150 mg/kg, is designed to protect children in residential settings. Because anticipated future use of Tank Farm 4 does not include residential development, this standard is used for comparative purposes only.

The U.S. EPA guidance (1994a) for CERCLA Sites and RCRA Corrective Action Facilities was also used to evaluate the detected lead result. This directive recommends a 400 ppm screening level for lead in soil designated for residential land use. For the primary reason stipulated above, this guidance is also used for comparative purposes only.

The B423234 and B423638 soil lead concentrations (10.6 mg/kg and 6.6 mg/kg) do not exceed either of these standards.

The groundwater at the site is not used for potable purposes, and as such, is not subject to the provisions of the SDWA. However, lacking appropriate and relevant regulatory requirements for this medium, the SDWA MCLs for chemicals detected in groundwater are used for comparison. The RIDEM groundwater standard is applicable to groundwater classified as "GAA" or "GA". These classifications represent groundwater resources suitable for drinking water use without treatment. Groundwater beneath Tank Farm 4 has been assigned a "GB" classification, which identifies it as a groundwater resource that is not suitable for drinking water use (RIDEM, 1993). Therefore, for "GB" classified groundwater, the RIDEM standard does not apply. It is also being used for comparative purposes only.

The arsenic, chromium, and lead concentrations in the MW-123 groundwater sample were evaluated with respect to MCLs and RIDEM groundwater standards (RIDEM, 1993; U.S. EPA, 1994b).

The federal and State of Rhode Island regulatory standard for arsenic in groundwater is 50 μg/L. In the MW-123 groundwater sample, arsenic was detected at a concentration of 33 μg/L. This concentration does not exceed either of the standards.

The federal and State of Rhode Island regulatory standard for chromium in groundwater is 100 μg/L. In the MW-123 groundwater sample, chromium was detected at a concentration of 25.8 μg/L. This concentration does not exceed either of the standards.

The federal and State of Rhode Island regulatory standard for lead in groundwater is 15 μg/L. According to the SDWA standard, this concentration represents an action level for a sample collected at the tap. In the MW-123 groundwater sample, total lead was detected at a concentration of 16 μg/L. Groundwater was not filtered and the turbidity of the sample exceeded 750 NTUs. Elevated turbidity is the result of installing a well screen with an aperture size of 0.020 inch in MW-123 to evaluate the presence of NAPL in soil at this location. If groundwater at the site were used as a source of drinking water, the supply well would be designed to minimize turbidity. A significant decrease in the lead concentration would likely result.

The arsenic, chromium, and lead concentrations in groundwater were also compared to RCRA groundwater protection standards (U.S. EPA, 1991). Each standard, 50 μg/L, is designed to ensure that hazardous constituents detected in the groundwater from a regulated unit do not exceed specified concentration limits. The concentrations of arsenic, chromium, and lead in the MW-123 groundwater sample do not exceed RCRA groundwater protection standards.

5.6.1 TPH Clean-up Levels

TPH clean-up levels are identified to develop remedies to protect human health and the environment and to ensure that the selected remedial alternative will properly address concerns at the site. Two objectives were considered in developing clean-up levels at Tank Farm 4 and these levels will be used to select appropriate future actions at the tank farm. The objectives are:

- Protect human health from risks on site associated with ingestion of, inhalation of, and dermal contact with impacted soils.
- Protect human health and the environment by controlling any off-site migration of contaminated groundwater (although no significant migration has occurred)

RIDEM has established guidance concentrations of TPH in soils which specifically apply to using excavated soil as backfill material following UST removal. RIDEM generally establishes UST-related soil and groundwater clean-up criteria on a case-by-case basis considering potential off-site migration of impacted groundwater, and the presence of site-specific potential human and ecological receptors.

5.6.1.1 Exposure Routes

A significant objective of a clean-up level is to minimize the effects of chemicals to human and environmental receptors. Potential exposure routes of impacted soils to humans include ingestion, dermal contact, and inhalation of fugitive dust from surface soils. Because most impacted soils are located beneath a minimum of 30 feet of "unimpacted" soils, these exposure pathways do not present a significant risk to humans at the site surface.

Several exposure pathways that have been identified through pathway modeling (B&R Environmental, 1996) include dermal contact of impacted soils by a construction worker who may be exposed during excavation activities or ingestion of small quantities of soil by workers or trespassers.

Potential inhalation of VOCs is not considered an exposure pathway at the site. No VOCs were detected in ambient air during health and safety monitoring conducted during site investigation field work. Sampling and analysis of soils during the PCA confirmed the presence of only very low concentrations of VOCs in impacted site soils and groundwater.

Ingestion of groundwater is not considered a potential exposure pathway because local groundwater resources are classified as a type "GB" aquifer (Code of Rhode Island Rules Number 12-100-006, Section 9 and Appendix II), which is not suitable for drinking. Also, Tank Farm 4 is not located within a groundwater reservoir or groundwater recharge area (Code of Rhode Island Rules Number 12-100-006, Appendix III and IV) and no public or private water supply wells are located downgradient of the farm. The only potential pathway of human exposure to petroleum-impacted groundwater is through dermal contact at areas of groundwater discharge to surface water bodies. Tank 42 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,830 feet to the west. Studies conducted during the Tank 50 SI have indicated that the mobility of the petroleum constituents in groundwater is minimal, even in areas where TPH in soil exceeds 10,000 mg/kg (B&R Environmental, 1995b). Therefore, the potential for human exposure to impacted groundwater is considered low.

Pathway modeling was conducted to identify potential exposures of ecological receptors at Tank 50, Tank Farm 5. The results of the modeling were presented in the Technology Screening Evaluation (B&R Environmental, 1996). The model can generally be applied to Tank 42, because tank construction methods are similar, and land development in the downgradient direction from Tank 42 is similar to areas downgradient of Tank 50. Results of the modeling indicated that no complete pathways exist for migration of impacted media to ecological receptors.

5.6.1.2 Proposed Clean-up Levels

RIDEM has established a policy of establishing site-specific TPH clean-up levels. TPH concentrations in soil of 2,500 mg/kg and 5,000 mg/kg will be proposed by the Navy as clean-up levels at Tank 42. These concentrations are considered conservative and were adopted as soil clean-up standards by Massachusetts and published as part of the MCP in November, 1993 (MADEP, 1993) and are not legally binding in Rhode Island.

These soil standards were established based on the characterization of risk posed by petroleum-impacted disposal sites. The MCP and various guidance and policy documents issued by the MADEP describe the documentation of site risk. Both groundwater usage (310 CMR:40.0931 and 40.0932) and accessibility to soil (310 CMR 40.0931 and 40.0933) are considered in the site risk characterization.

The proposed clean-up level of 2,500 mg/kg TPH in soil considers that soils may be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(b)), and are "potentially accessible," described as being "located at a depth of 3 - 15 feet below the surface..." (310 CMR 40.0933(4)(c)).

The proposed clean-up level of 5,000 mg/kg TPH in soil considers that soils may also be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(a)), and are "isolated," described as being "located at a depth greater than 15 feet below the surface..." (310 CMR 40.0933(4)(c)). The applicable sections of the MCP are included in Appendix E.

5.7 FUTURE ACTIONS

The following section presents recommended future actions at Tank 42. Evaluation of an interim action is included.

5.7.1 Source Control

Tank contents removal and cleaning was completed in December 1995. Product was removed from the tank and the tank was cleaned and ballasted with clean water. The tank will be inspected and closed following approval by RIDEM.

5.7.2 Interim Action

Groundwater levels were lowered to the elevation of the tank bottom during tank closure operations. The ring drain system was used to manage the groundwater level at the tank for the duration of closure activities, a period of approximately two months. During the pumping operations, some NAPL may be removed from the impacted fill materials in the tank socket in conjunction with groundwater withdrawal. This pumping action may result in removal of contaminant mass from the system, thereby lowering petroleum concentrations at the site.

Following the interim action, additional groundwater and subsurface soil samples will be collected from zones of petroleum-impacted soil that were identified during the SI as exceeding proposed clean-up standards. Samples will be analyzed by Method 418.1, and compared to results of analyses conducted during the SI.

The need for additional remedial action will be evaluated based on the results of the interim action.

6.0 TANK 45 SITE INVESTIGATION

Section 6.0 summarizes investigations conducted to evaluate the nature and extent of petroleum-impacted soils and groundwater, and effects to human health and the environment at Tank 45. The PCA evaluated the impacts to soil and groundwater of past petroleum storage and handling practices at each of the Tank Farm 4 and 5 USTs, including Tank 45. Results of the PCA indicated the need for conducting a site investigation at Tank 45.

<u>Preliminary Closure Assessment</u>

Specific soil and groundwater sampling methods, and soil boring and monitoring well construction techniques are described in detail in the final Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5, dated September 1994 (HNUS, 1994). Additional RIDEM comments, which addressed initiating soil sampling at the water table, and containerizing all IDW were conveyed to the B&R Project Manager and the NETC representative (personal communication).

GPR and utility location surveys were conducted by a subcontractor to B&R Environmental to identify the UST edges and associated piping to facilitate the borehole placement.

The PCA field investigation was conducted by B&R Environmental from October to December 1994. The objective of the study was to evaluate the impacts of past site activities on soil and groundwater by collecting and analyzing soil and groundwater samples. The PCA involved advancing one soil boring (B-45), and subsequently installing a groundwater monitoring well, MW-122, in the boring on the hydraulically downgradient side of Tank 45.

Soil sampling was initiated at 26 feet bgs, the estimated depth of the water table in MW-122, and continued to the end of the boring, approximately 40 feet bgs. Soil cuttings and air samples at each borehole were monitored with photo and flame ionization detectors (PIDs and FIDs). Visual and olfactory evidence of the presence of petroleum was noted on boring logs (Appendix B).

Selected soil samples were screened with an Ensys immunoassay kit for the presence of TPH. The sample that exhibited the highest concentration of petroleum components, as determined by immunoassay results, was generally selected for laboratory analysis. Soil samples selected for laboratory analysis were analyzed by EPA methods for volatile and semi-volatile organic compounds, TPH, and the eight RCRA metals. Groundwater samples were analyzed for the above parameters, with the exception of TPH. The objective of the soil boring and groundwater monitoring well is summarized in Table 6-1.

Four soil probings, P-1, P-2, P-3, and P-4 were also advanced on the hydraulically downgradient side of the shunt piping at Tank 45 to evaluate the presence of petroleum-impacted soil. The probings were performed using a combination of standard solid-stem auger methods, advancing a 2.5-inch diameter drive point, and advancing an open hole with a split-spoon sampler. Two split-spoon samples were then obtained from 4 to 6 and 6 to 8 feet bgs. A review of the best available data determined that the piping lay no deeper than 5 feet bgs. Later work and investigations at Tank Farm 5 indicated that the piping is located 6 to 8 feet bgs (Jalkut, 1995b). The soil samples were screened using the Ensys Petro Risc immunoassay kit for the presence of petroleum hydrocarbons, and the sample exhibiting the highest concentration of petroleum in each probing was submitted for laboratory analysis. Probing field logs are presented in Appendix B.

<u>Site Investigation</u>

The SI was conducted between September and October 1995, and focused on delineating the extent of TPH in soil and groundwater. During the SI field effort, seven soil borings were advanced and two surface soil samples were collected (Figure 6-1). Of the seven soil borings, three, SB-330, SB-331, and SB-332, were advanced through the unconsolidated overburden, and completed as groundwater monitoring wells, MW-330, MW-331, and MW-332.

In SB-330, SB-333, and SB-334, split-barrel soil sampling was initiated at the ground surface and continued to the end of the boring at refusal in order to define the vertical extent of petroleum--impacted soils. In the remainder of the borings, samples were collected at standard intervals (5-foot intervals), and continuously from the water table to the end of the boring at refusal.

Three borings, SB-333, SB-334, and SB-336, were advanced downgradient of the tank outside the socket, in the unconsolidated overburden and were backfilled. One boring SB-335, was advanced downgradient of the PCA well through the unconsolidated overburden and was backfilled. SB-335 may be within the socket area. Soil boring and well construction logs are presented in Appendix B and C, respectively. Analytical data is reported in Appendix D. The objective of each soil boring and groundwater monitoring well is summarized in Table 6-1.

TABLE 6-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
B-45/(MW-122)	PCA	Downgradient to Tank 45; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide data on presence of TPH impacted groundwater.
SB-330/(MW-330)	SI	Crossgradient of Tank 45; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide data on presence f TPH impacted groundwater. Provide a data point for aquifer characterization.
SB-331/(MW-331)	SI	Crossgradient of Tank 45; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide data on presence of TPH impacted groundwater. Provide a data point for aquifer characterization.
SB-332/(MW-332)	SI	Upgradient of Tank 45; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide data water level of groundwater.
SB-333	SI	Down- and cross-gradient of Tank 45; outside area of socket;	NA	Provide data on presence of TPH impacted soils.	NA
SB-334	SI	Downgradient of Tank 45; outside area of socket;	NA	Provide data on presence of TPH impacted soils.	NA
SB-335	SI	Slightly crossgradient of Tank 45near PCA well; within area of socket;	NA	Provide data on presence of TPH impacted soils.	NA
SB-336	SI	Down- and cross-gradient of Tank 45; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
P-1	PCA	D wngradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA

TABLE 6-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 2

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
P-2	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
P-3	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
P-4	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
SS-01	SI	Top of Tank 51 roof - east side, near former location of small manway.	Provide data on presence of TPH impacted soils above the tank lid.	NA	NA
SS-02	SI	Top of Tank 51 roof - west side, near large manway with door.	Provide data on presence of TPH impacted soils above the tank roof.	NA	NA

Legend:

PCA - Preliminary Closure Assessment
SI - Site Investigation
NA - Not Applicable

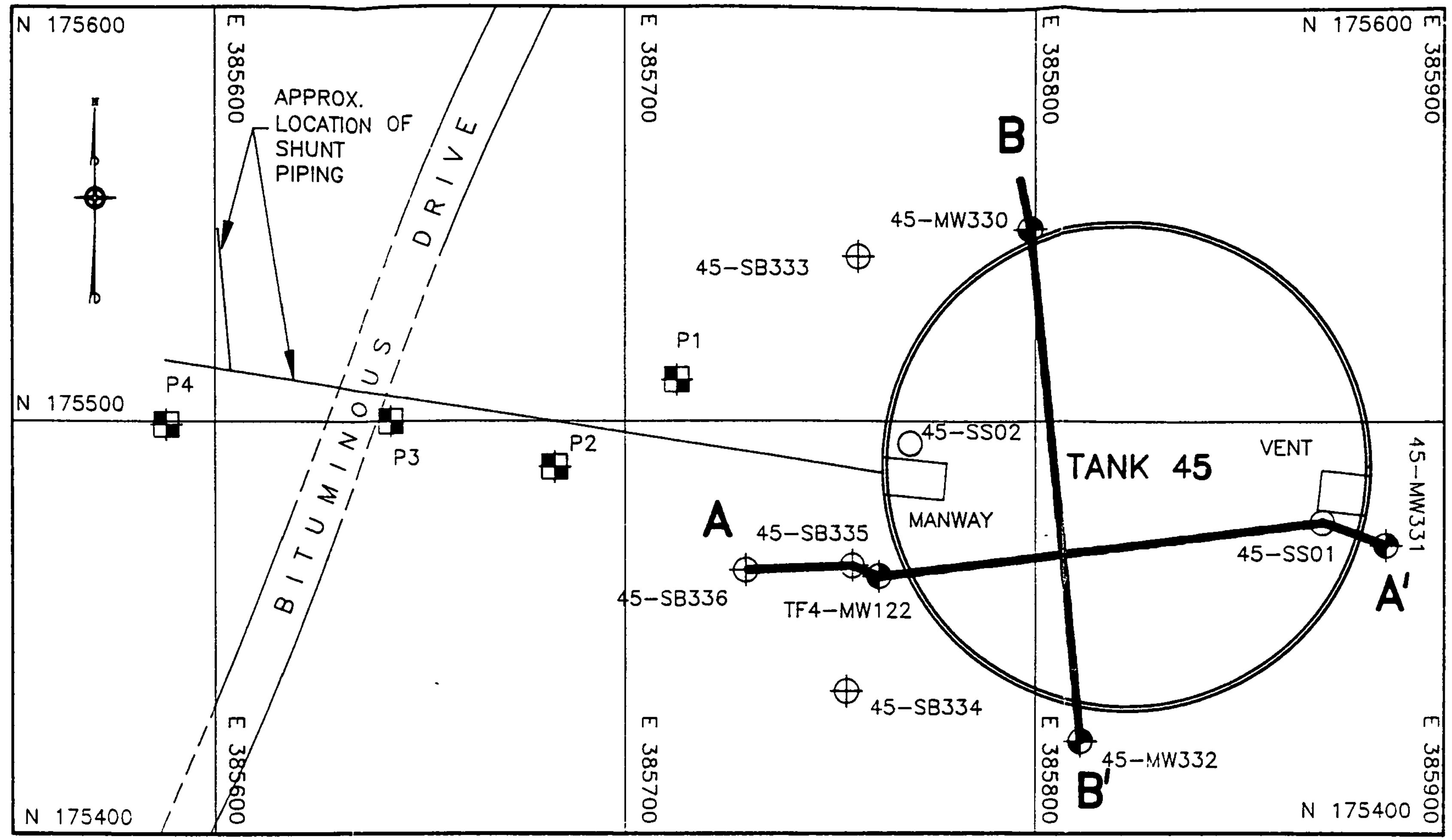
LEGEND

45–SB333 — SOIL BORING LOCATION WITH IDENTIFIER

45–MW330 — MONITORING WELL LOCATION WITH IDENTIFIER

45–SS02 — SURFACE SOIL SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER



GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET

NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.
2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.
3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

CROSS–SECTION LOCUS PLAN – TANK 45				FIGURE 6–1
NETC–NEWPORT, RI				
SITE INVESTIGATION REPORT – TANK FARM 4				Brown & Root Environmental
DRAWN BY:	R.G. DEWSNAP	REV.:	0	A Division of Halliburton NUS Corporation
CHECKED BY:	J.B. HOLDEN	DATE:	23 FEB 96	55 Jonspin Road Wilmington, MA 01887
SCALE:	1" = 40'	FILE NO.: 0:\DWG\NETC\SI-38-48\FIG_6-1		(508)658-7899

6.1 ANALYTICAL METHODS

The following section summarizes analytical methods and results of work conducted during the PCA and the SI.

EPA-approved laboratory methods were used to evaluate soil and groundwater samples at the site. Detailed descriptions of specific field procedures and analytical methods are presented in the "Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5", dated September 1994 (HNUS, 1994), with Addendum 1 (HNUS, 1995c), and Addendum 2 (HNUS, 1995d).

Throughout each investigation, soil and groundwater samples were collected and analyzed according to Naval Facilities Engineering Service Center (NFESC) requirements. All environmental samples collected as part of these investigations, including QC samples, were stored and shipped in accordance with chain-of-custody procedures outlined in the project-specific Quality Assurance/Quality Control, Plan, prepared as part of the Work Plan.

6.1.1 Field Screening

Preliminary Closure Assessment

Because Tank 45 had been used to store virgin No. 6 fuel oil and possibly No. 2 fuel oil, environmental media were analyzed for parameters typically associated with petroleum components. During the PCA investigation, soil samples were visually inspected for the presence of petroleum, and were screened with PIDs and FIDs, and an Ensys Petro Risc immunoassay kit. Generally, PIDs were used for health and safety screening for VOCs, while FIDs were used for soil screening for VOCs and SVOCs. Results of Ensys TPH screening were confirmed by laboratory analysis.

Site Investigation

During the SI investigation, soil samples were visually inspected for the presence of petroleum and screened with FIDs. Results of TPH screening were confirmed by laboratory analysis.

6.1.2 Laboratory Analysis

Preliminary Closure Assessment

During the PCA, sample analyses were conducted by Ceimic Laboratories of Narragansett, Rhode Island. Ceimic is a NFESC-approved laboratory.

EPA-approved analytical methods were used for laboratory analyses. Soil samples were analyzed for TCL volatile organic compounds (Method SW-846 8240); TCL semi-volatile organic compounds (Method SW-846 8270); and RCRA metals (Method SOW ILMO 3.0) to evaluate potential impacts to soil from sludge pits reported to exist on site. TPH extractables (Method SW-846 8015) were analyzed to evaluate potential impacts of releases of petroleum from USTs to soil. Groundwater samples were not analyzed for TPH, but otherwise were analyzed for the same parameters.

Site Investigation

Samples collected and analyzed during the SI were analyzed for TPH (Method SW-846 418.1). Soil samples were also analyzed for several engineering parameters that will be used to evaluate potential remedial alternatives. Parameters and analytical methods include: grainsize (ASTM D421/422), moisture content (ASTM 2216), heterotrophic plate count (SM 9215 modified), sediment oxygen demand (modified BOD Method SM 5210B), chemical oxygen demand (E 410.1 modified), total phosphorus (E 365.4 modified), nitrate (SW 9200), and total organic carbon (TOC-SW/9060). TPH analyses were conducted by Ceimic, heterotrophic plate counts by Nytest Environmental Inc., and grainsize by Geotechnics. Laboratory analytical results are presented in Appendix D.

TPH extractables were analyzed during the PCA using Method 8015 to identify a petroleum fingerprint. During the SI, TPH was analyzed using Method 418.1 because the Rhode Island action level guidance is based on Method 418.1. Analysis conducted during the PCA indicated minimal concentrations of VOCs in soil and groundwater. Soils present within the investigation areas are organic-poor mineral soils. Method 418.1 analyzes the total number of carbon-hydrogen bonds in a sample, while Method 8015 is specific to petroleum hydrocarbons. The low organic characteristics of a mineral soil minimizes the potential for interference caused by elevated levels of organic compounds when using Method 418.1. Data analyzed using Method 418.1 is therefore considered roughly comparable to data analyzed using Method 8015.

6.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT

MW-122 was installed as part of the PCA field investigation and is located hydraulically downgradient of Tank 45, approximately 5 feet from its perimeter (Figure 6-1). The well screen was set 34 to 39 feet bgs to correspond with petroleum-impacted coarse grained fill material present above the ring drain.

The upper 26 feet of the boring were not examined. Soil sampling was initiated at 26 feet based on historical data indicating that the water table was approximately 26 feet bgs. It was presumed that petroleum releases above the water table would migrate vertically downward and be detected in soil and possibly groundwater. Soil sampling was continuous from 26 feet bgs to refusal at approximately 40 feet. The interval from 26 to 36 feet bgs is comprised of sandy gravelly silt. A PID detection of 90 ppm was noted over the interval from 28 to 30 feet bgs. Subangular gravel was observed from 36 to 38 feet bgs. During the advance of the boring, petroleum staining was detected on gravels at approximately 33 feet bgs. Gravels at 34 to 40 feet bgs were heavily stained with petroleum. The interval from 34 to 40 feet bgs is comprised of petroleum-impacted sandy gravelly silt and sandy silty gravel.

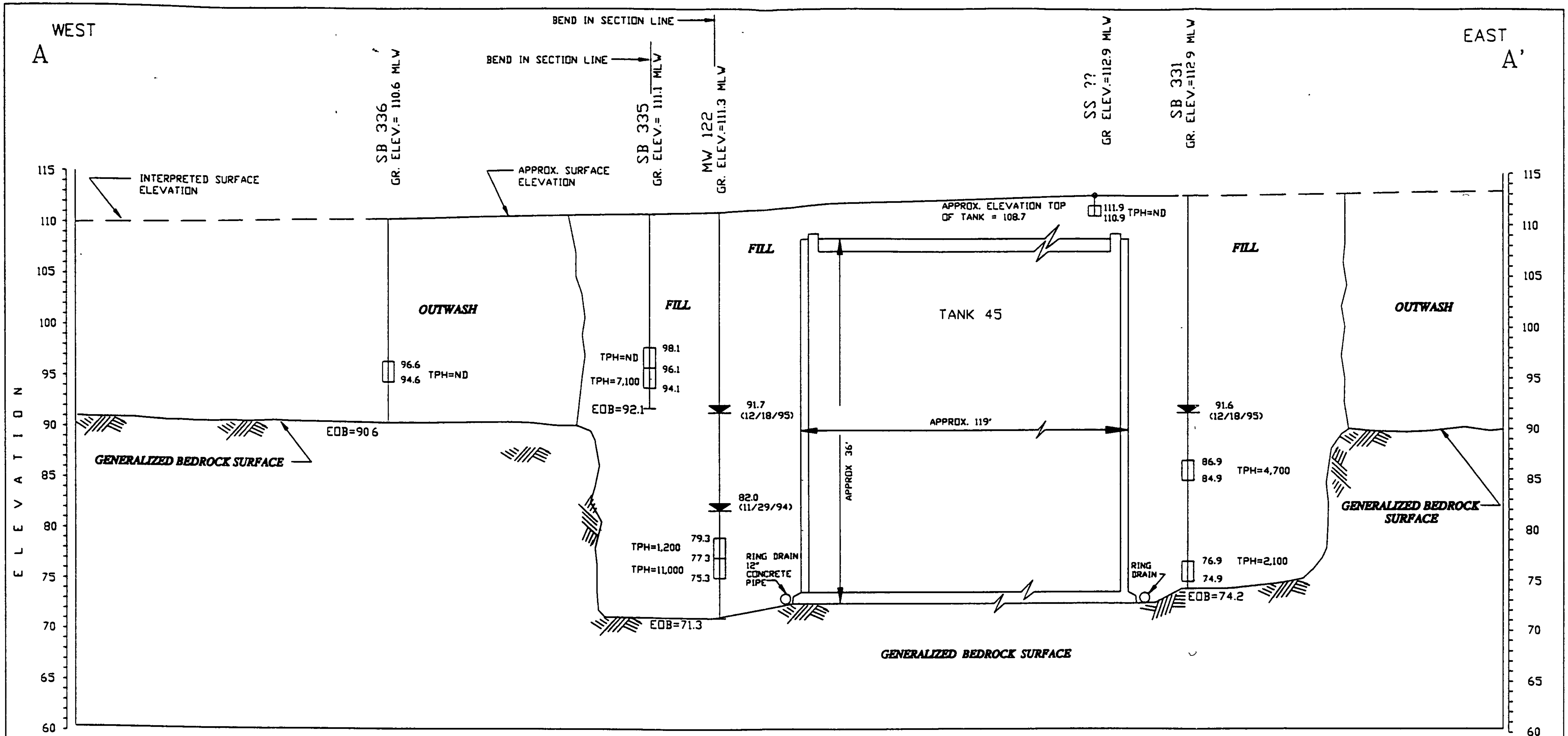
Highly weathered slate was noted at refusal at approximately 40 feet bgs, and the boring was terminated. The boring log is presented in Appendix B.

On November 29, 1994, the depth to the water table was 29.30 feet bgs as measured in MW-122. Seasonal and precipitation effects on groundwater levels have not been evaluated at the site.

6.2.1 <u>Analytical Data Summary</u>

The PCA subsurface investigation included soil sampling during the advancement of MW-122 (B-45) and subsequent groundwater sample collection and analysis. Investigations conducted during the PCA focused on determining the nature of fuel oil compounds that impacted soil and groundwater.

During the PCA, two subsurface soil samples (B453234 and B453436) were selected for analysis from B-45 (MW-122), located near Tank 45. These samples were collected from depths of 32 to 34 feet bgs, and 34 to 36 feet bgs, and consisted of sandy gravelly silt (Figure 6-2). Subsurface soil sample B453436 was heavily impacted by petroleum and contained NAPL. Following standard well development and well purging procedures, a groundwater sample was collected from the midpoint of



LEGEND

91.6 (12/18/95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

96.9 / TPH=4,700 / 84.9 — SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
SS-01	SURFACE SOIL SAMPLE NUMBER

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

N O T E:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN SOIL

CROSS-SECTION A-A' - TANK 45			
NETC-NEWPORT, RI			
SITE INVESTIGATION REPORT - TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	17 JAN 96
SCALE:	1" = 10' (APPROX.)	FILE NO.:	\DWG\NETC\SI-38-48\XSECT45A

FIGURE 6-2

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

the well screen, approximately 36.5 feet bgs. Immiscible oil droplets were observed in the groundwater sample.

Four subsurface soil samples were selected for analysis from the soil probings downgradient of the shunt piping for Tank 45. Two of these samples were collected from depths of 6 to 8 feet bgs (samples P-1-45-0608 and P-2-45-0608), and two from depths 4 to 6 feet bgs (samples P-3-45-0406 and P-4-45-0406). Samples P-1, P-3, and P-4 consisted of sandy silt, while sample P-2 consisted of sandy gravelly silt.

Positive organic and inorganic analytes detected in soil and groundwater are reported in Table 6-2. Complete laboratory analytical results are reported in Appendix D.

6.2.1.1 Subsurface Soils in Tank Socket

<u>Volatile Organic Compounds (VOCs)</u>

No volatile organic compounds were present above detection limits in subsurface soil sample B453234. Toluene and 1,2,4-trichlorobenzene (1,2,4, TCB) were detected at concentrations of 7 μg/kg and 70 μg/kg in subsurface soil sample B453436. Toluene is a component of petroleum products, particularly gasoline. 1,2,4 TCB has multiple industrial uses, including use as a degreasing agent (Howard, 1989).

<u>Semi-Volatile Organic Compounds (SVOCs)</u>

Ten SVOCs, ranging in concentration from 39 μg/kg to 1,300 μg/kg were detected in subsurface soil samples B453234 and B453436.

Fluorene, phenanthrene, pyrene, and bis(2-ethylhexyl)phthalate (BEHP) were detected in both samples, at concentrations ranging from 52 μg/kg to 1,300 μg/kg. Anthracene, fluoranthene, chrysene, 2-nitroaniline, diethyl phthalate, and di-n-butyl phthalate were detected in subsurface soil sample B453436 in concentrations ranging from 39 μg/kg to 1,000 μg/kg.

Fluorene, phenanthrene, pyrene, anthracene, fluoranthene, and chrysene are PAHs, typically derived from coal tar (Shreve and Brink, 1977; Morrison and Boyd, 1983). They are also common organic compounds identified in fuel oil (Dragun, 1988).

W5296104F

TABLE 6-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-45	32-34	Fluorene	52 μg/kg	None	N/A
Soil	B-45	32-34	Phenanthrene	130 μg/kg	None	N/A
Soil	B-45	32-34	Pyrene	59 μg/kg	None	N/A
Soil	B-45	32-34	Bis(2-ethylhexyl)phthalate	830 μg/kg	None	N/A
Soil	B-45	32-34	Arsenic	9.0 mg/kg	None	N/A
Soil	B-45	32-34	Barium	14.4 mg/kg	None	N/A
Soil	B-45	32-34	Cadmium	1.8 mg/kg	None	N/A
Soil	B-45	32-34	Chromium	11.0 mg/kg	None	N/A
Soil	B-45	32-34	Lead	8.0 mg/kg	150 ppm (4) 400 ppm (5)	No
Soil	B-45	34-36	Toluene	7 μg/kg	None	N/A
Soil	B-45	34-36	1,2,4-Trichlorobenzene	70 μg/kg	None	N/A
Soil	B-45	34-36	2-Nitroaniline	56 μg/kg	None	N/A
Soil	B-45	34-36	Diethyl phthalate	1000 μg/kg	None	N/A

TABLE 6-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 4

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	CONTAMINANT	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-45	34-36	Fluorene	600 μg/kg	None	N/A
Soil	B-45	34-36	Phenanthrene	390 μg/kg	None	N/A
Soil	B-45	34-36	Anthracene	390 μg/kg	None	N/A
Soil	B-45	34-36	Di-ni-butyl phthalate	75 μg/kg	None	N/A
Soil	B-45	34-36	Fluoranthene	39 μg/kg	None	N/A
Soil	B-45	34-36	Pyrene	1300 μg/kg	None	N/A
Soil	B-45	34-36	Chrysene	390 μg/kg	None	N/A
Soil	B-45	34-36	Bis(2-ethylhexyl)phthalate	110 μg/kg	None	N/A
Soil	B-45	34-36	Arsenic	11.4 mg/kg	None	N/A
Soil	B-45	34-36	Barium	9.2 mg/kg	None	N/A
Soil	B-45	34-36	Cadium	2.05 mg/kg	None	N/A
Soil	B-45	34-36	Chromium	10.7 mg/kg	None	N/A
Soil	B-45	34-36	Lead	7.65 mg/kg	150 ppm (4) 400 ppm (5)	No

TABLE 6-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 3 OF 4

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	CONTAMINANT	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Groundwater	MW-122	34-39	Fluorene	16 μg/L	None	N/A
Groundwater	MW-122	34-39	Phenanthrene	15 μg/L	None	N/A
Groundwater	MW-122	34-39	Pyrene	15 μg/L	None	N/A
Groundwater	MW-122	34-39	Arsenic	656 μg/L	50 μg/L (2), (3), (6)	Yes
Groudwater	MW-122	34-39	Barium	1530 μg/L	2000 μg/L (2) & (3) 1000 μg/L (6)	No (1) (3) Yes (6)
Groundwater	MW-122	34-39	Chromium	496 μg/L	100 μg/L (2) & (3) 50 μg/L (6)	Yes
Groundwater	MW-122	34-39	Lead	722 μg/L	15 μg/L (2) & (3) 50 μg/L (6)	Yes
Groundwater	MW-122	34-39	Mercury	0.52 μg/L	2 μg/L (2), (3), (6)	No
Groundwater	MW-122	34-39	Silver	29.0 μg/L	50 μg/L (6)	No

TABLE 6-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 4 OF 4

Legend:

ppm	-	parts per million
μg/L	-	micrograms per liter
mg/kg	-	milligrams per kilogram
μg/kg	-	micrograms per kilogram
N/A	-	Not Applicable

Notes:

(1) Comparisons to Regulatory Standards and Guidelines are discussed in Section 6.6.

(2) U.S. EPA Drinking Water Regulations and Health Advisories, EPA 822-R-94-001, May 1994.

(3) State of Rhode Island Department of Environmental Management, Rules No. 12-100-006, Rule and Regulations for Groundwater Quality, Section 10, July 1993.

(4) Rhode Island Department of Health - Environmental Lead Program, [R23-24.6-PB], Rules and Regulations for Lead Poisoning Prevention, February 1992 (with amendments).

(5) OSWER Directive 9355.4-12- Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.

(6) 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart F, Sections 264.92 - 264.94, July 1991.

- MW-122 was installed in boring location B-45.
- Analytical results of duplicated samples were averaged.

Diethyl phthalate, di-n-butyl phthalate, and BEHP are typically used as plasticizers in manufacturing PVC and other plastics (Howard, 1989; Sittig, 1981), including plastics used in analytical laboratories.

RCRA 8 Metals

Arsenic, barium, cadmium, chromium, and lead were detected in both subsurface soil samples (B453234 and B453436), collected from boring B-45. These metals are constituents of naturally occurring soils, however the source of these analytes has not been determined.

Total Petroleum Hydrocarbons (TPH)

A TPH concentration of 1,200 mg/kg was detected by laboratory analysis (Method 8015) in sample B453234. A TPH concentration of 11,000 mg/kg was detected by laboratory analysis in subsurface soil sample B453436. The petroleum was identified as bunker oil.

One subsurface soil sample was collected for TPH immunoassay field screening from 30 to 32 feet bgs. The TPH screening result was greater than 100 ppm and is consistent with the presence of petroleum in this interval. Field screening data tables are presented in Appendix D.

6.2.1.2 Groundwater in Tank Socket

Volatile Organic Compounds (VOCs)

No volatile organic compounds were present above detection limits in the groundwater sample collected from MW-122.

Semi-Volatile Organic Compounds (SVOCs)

Three SVOCs, ranging in concentration from 15 μg/L to 16 μg/L were detected in the groundwater sample collected from MW-122. These compounds included: fluorene, phenanthrene, and pyrene.

RCRA 8 Metals

Arsenic, barium, chromium, lead, mercury, and silver were detected in the groundwater sample collected from MW-122. The source of these analytes may be a result of elevated turbidity (200 NTUs) in the groundwater sample. Metals typically are adsorbed onto silt and clay sized suspended particulates (Puls and Powell, 1992). These particulates are usually removed from formation materials in the vicinity of the well by developing the well.

The migration of silt and clay into a well is further minimized by a properly sized filter pack and well screen. At the direction of RIDEM, a 0.020 inch slot size screen section was installed in wells located within zones containing NAPL. This size screen aperture requires a larger sized filter pack, which is too large to retain the high silt and clay content of the fill materials in which the well is screened. The finer formation materials will continue to enter the well screen. The purpose of installing a relatively large screen aperture was to ensure that NAPL could enter the well so that the presence of NAPL could be evaluated. The 0.020 inch screen aperture size does allow the entry of NAPL into wells at the site.

6.2.1.3 Shunt Piping

<u>Total Petroleum Hydrocarbons (TPH)</u>

Two subsurface soil samples were collected for TPH immunoassay field screening from each soil probe. The samples were collected from 4 to 6 feet bgs, and 6 to 8 feet bgs. TPH screening results were used to determine which samples to send for lab analysis. Field screening data tables are presented in Appendix D.

TPH was not detected by laboratory analysis (Method 8015) in the soil probing samples (Table 6-3).

6.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION

The following section presents the findings of the SI field effort. Sampling and analysis focused on determining the extent of petroleum-impacted soils and groundwater. TPH results collected during the PCA will also be discussed here to present a comprehensive evaluation of TPH data.

Soil and groundwater samples were collected and analyzed for TPH by EPA Method 418.1. Results of TPH analyses in subsurface soils and groundwater are reported in Tables 6-3 and 6-4. Soil samples were collected for grainsize analysis, percent moisture, sediment oxygen demand (SOD) or modified biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), heterotrophic plate count, total phosphorus, and nitrate (Table 6-5). This group of soil sample analyses is termed "engineering parameters" for discussion purposes. Results of these analyses are reported

TABLE 6-3
TPH IN SUBSURFACE SOIL
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING NO.	DEPTH SAMPLED	CONCENTRATION (mg/kg)	FIELD EVENT	EXCEEDS GUIDELINE OF (YES/NO)[1]	
				2,500 mg/kg	5,000 mg/kg
B-45/(MW-122)	32-34	1,200 (Bunker Oil)[2]	PCA	NA	No
B-45/(MW-122)	34-36	11,000 (Bunker Oil)[2]	PCA	NA	Yes
P-1	6-8	ND[2]	PCA	No	NA
P-2	6-8	ND[2]	PCA	No	NA
P-3	4-6	ND[2]	PCA	No	NA
P-4	4-6	ND[2]	PCA	No	NA
SB-330/(MW-330)	30-32	1,400[3]	SI	NA	No
SB-330/(MW-330)	38-40	23,000[3]	SI	NA	Yes
SB-331/(MW-331)	26-28	3,900[3]	SI	NA	No
SB-331/(MW-331)	36-38	2,100[3]	SI	NA	No
SB-332/(MW-332)	26-28	ND[3]	SI	NA	No
SB-332/(MW-332)	34-36	2,700[3]	SI	NA	No
SB-333	20-22	ND[3]	SI	NA	No
SB-334	18-20	ND[3]	SI	NA	No
SB-335	13-15	ND[3]	SI	No	NA
SB-335	15-17	7,100[3]	SI	NA	Yes
SB-336	14-16	ND[3]	SI	No	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
NA - Not Applicable
PCA - Preliminary Closure Assessment
SI - Site Investigation
(1) - Comparisons to Regulatory Standards and Guidelines are discussed in Section 6.6
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

TABLE 6-3
TPH IN SUBSURFACE SOIL
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 2

Notes:

Guideline is 2,500 mg/kg for depth 3-15 ft, 5,000 mg/kg for depths greater than 15 ft.

- MW-122 was installed in boring location B-45.
- Analytical results of duplicate samples were averaged.

TABLE 6-4
TPH IN GROUNDWATER
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Well No.	Well Screen Depth Interval (ft bgs)	TPH Concentration in Groundwater (mg/L)	TPH Concentration in Soil at Screen Interval (mg/kg)(1)	Groundwater Sample Date
MW-122	34-39	NA	11,000 (Bunker Oil)(2)	11/1994
MW-330	28-38	6.3(3)	1,400(3)	10/1995
			23,000(3)	10/1995
MW-331	27.5-37.5	9.3(3)	4,700(3)	10/1995
			2,100(3)	10/1995
MW-332	28-38	NS	ND(3)	NS
			2,700(3)	NS

Legend:

mg/L - milligram per liter
ft bgs - Feet Below Ground Surface
ND - Not Detected
NS - Not Sampled due to low water yield
NA - Not Analyzed for TPH
(1) - The soil sample interval is coincident with or overlaps the well screen interval.
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

MW-122 was installed in boring location B-45.

- Analytical results of duplicate samples were averaged.

TABLE 6-5
SUMMARY OF ENGINEERING PARAMETERS - POSITIVE DETECTS IN SUBSURFACE SOIL SAMPLES
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC-NEWPORT, RHODE ISLAND

Boring ID	Sample Depth (ft bgs)	SOD (mg/kg)	COD (mg/kg)	TOC (mg/kg)	Nitrate-Nitrite (as N)	Total Phosphorous (as P) (mg/kg)	Heterotrophic Plate Count (cfu/g)	Percent Moisture	Grain Size
SB-330	14-16	NA	NA	NA	NA	NA	NA	11.4	Appendix D
SB-330	30-32	179	520	9,640	ND	ND	2,400	NA	NA
SB-331	26-28	NA	NA	NA	NA	NA	NA	11.8	Appendix D
SB-331	36-38	2,160	348	8,750	ND	ND	2,400	NA	NA
SB-331	38-40	NA	NA	NA	NA	NA	NA	7.5	Appendix D
SB-332	28-30	NA	NA	NA	NA	NA	NA	10.8	Appendix D
SB-332	34-36	2,510	931	13,600	ND	ND	3,600	NA	NA

Legend:

SOD - Sediment Oxygen Demand (Modified Biochemical Oxygen Demand Method)
COD - Chemical Oxygen Demand
TOC - Total Organic Carbon
ft bgs - feet below ground surface
mg/kg - milligram per Kilogram reported on a dry weight basis
cfu/g - colony forming units/gram
ND - Not Detected
NA - Not Analyzed

here for informational purposes only. The data will be evaluated as part of the assessment of remedial technologies, presented under separate cover. Complete laboratory analytical results are presented in Appendix D.

6.3.1 Subsurface Soils

At Tank 45, the highest concentration of TPH (23,000 mg/kg) was detected in a subsurface soil sample collected from MW-330, at 38.0 to 39.5 feet bgs (Figure 6-3). The design depth of the ring drain is approximately 38 feet bgs. MW-330 is located within the tank socket, on the downgradient side of the tank.

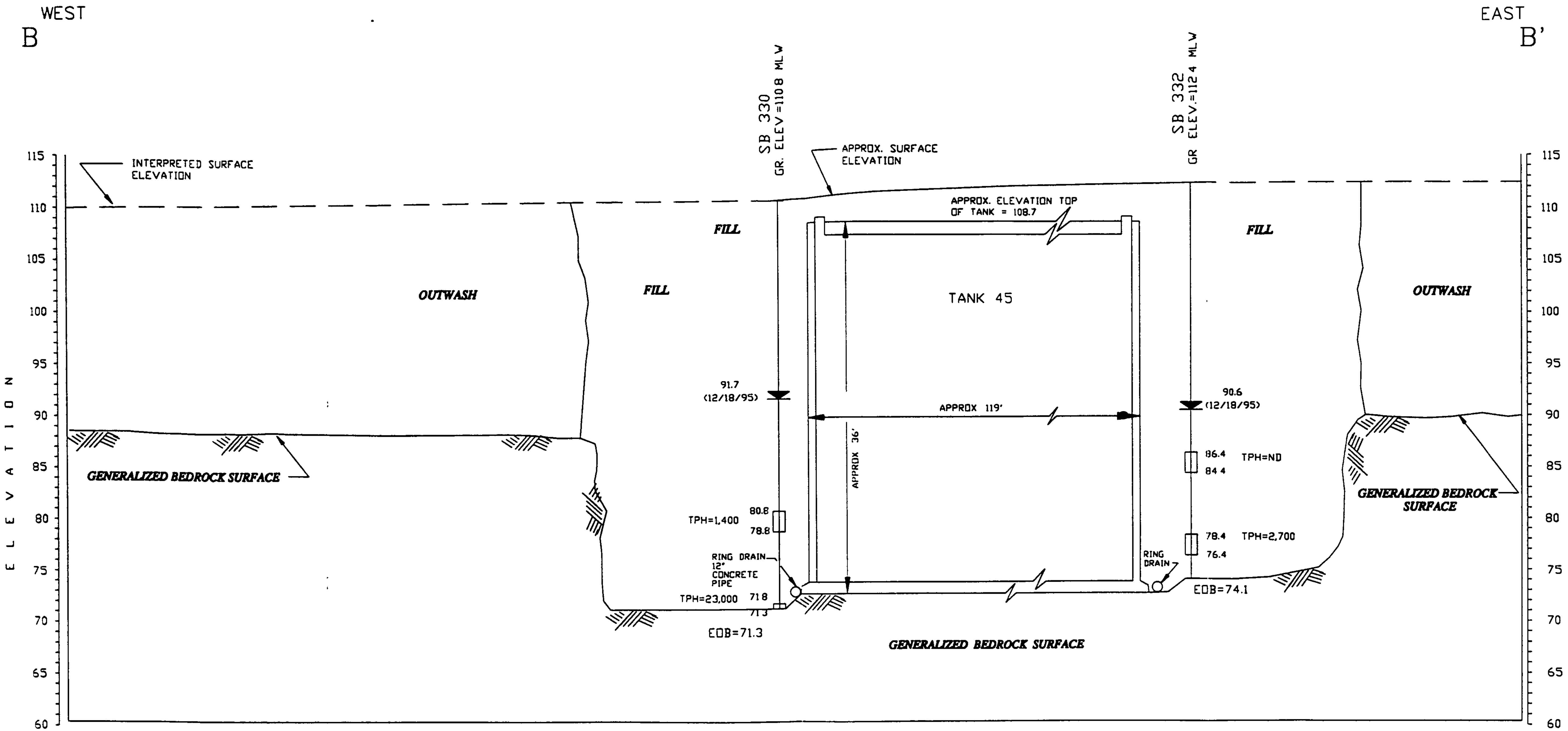
TPH was detected in soil samples collected from a corresponding depth below ground surface at MW-331 (up-gradient of the tank) and MW-332 (cross-gradient of the tank), located within the socket area of the tank (Figure 6-2 and 6-3). TPH concentrations in samples collected from MW-331 and MW-332 were 2,100 mg/kg and 2,700 mg/kg, respectively. Results indicate that the fill materials in the lower portion of the tank socket are impacted by petroleum, and that NAPL is present throughout coarse grained fill materials at this location.

Soil boring SB-335 was advanced several feet downgradient of MW-122, the PCA well, through the unconsolidated overburden within the socket area. TPH was detected at a concentration of 7,100 mg/kg in a soil sample collected from 15 to 17 feet bgs.

Two soil borings, SB-333 and SB-336, were advanced approximately 25 feet downgradient of the tank to investigate the downgradient extent of petroleum-impacted soils (Figures 6-1 and 6-2). TPH was below detection limits in soil samples collected from these borings. Boring logs are included in Appendix B, and analytical results are included in Appendix D.

In summary, TPH-impacted soils were noted from 26 feet bgs to the bedrock surface at approximately 40 feet bgs in the socket surrounding Tank 45. NAPL was noted in soils throughout this interval, and at SB-335; laboratory analysis detected TPH in soils at a concentration of 7,100 mg/kg from 15 to 17 feet bgs. TPH was not detected in soil borings located outside of the socket approximately 25 feet downgradient of the tank.

The TPH pattern identified by laboratory analyses of soils collected at Tank 45 during the PCA report was bunker oil. Personal communications have indicated that bunker oil and possibly No. 2 fuel oil were stored at Tank Farm 4 (Martin, 1995a). Most laboratory results indicated the presence of heavy



LEGEND

91.7 (12/18/96)	WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)
80.8 TPH=1,400 78.8	SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION
TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
SS-01	SURFACE SOIL SAMPLE NUMBER

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT

NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN

TPH IN SOIL

CROSS-SECTION B-B' - TANK 45			
NETC-NEWPORT, RI			
SITE INVESTIGATION REPORT - TANK FARM 4			
DRAWN BY	R.G. DEWSNAP	REV.:	0
CHECKED BY.	J. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.:	\DWG\NETC\SI-38-48\XSECT45B

FIGURE 6-3

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F

oils in soil samples, including bunker oil. Mr. Henry Liebowitz (Ceimic) indicated that weathered bunker oil and No. 6 fuel oil often cannot be differentiated (Martin, 1995b).

6.3.2 Groundwater

One groundwater sample round was collected in November 1994 during the PCA. One groundwater sample round was collected in October 1995 as part of the SI.

Table 6-4 presents the results of groundwater TPH analyses during this investigation. Concentrations of TPH in groundwater range from 6.3 to 9.3 mg/L. A comparison of TPH concentrations in groundwater is made with a corresponding 2-foot split-barrel soil sample interval. Little correlation exists between TPH concentrations in soil and TPH concentrations in groundwater. However, concentrations of TPH in groundwater are relatively low, despite the presence of TPH up to 23,000 mg/kg in soil.

The presence of only low concentrations of fuel-related compounds in groundwater adjacent to Tank 45 indicates that groundwater is not a significant migration pathway for heavy fuel oil compounds released from the tank. The compounds detected in groundwater are present at concentrations significantly lower than their water solubilities. Interpretation of these data suggests that dissolution of the free-phase petroleum into groundwater is minimal, possibly the result of a limited contact area of residual NAPL with groundwater.

6.3.3 Hydraulic Conductivity Measurements

Hydraulic conductivity testing was conducted in two wells at Tank 45, MW-330 and MW-331. Additional testing was conducted at Tank 48 and Tank 50 (during the SI conducted at Tank 50, Tank Farm 5, B&R Environmental, 1995b), as described in Section 3.3.2.

Interpretation of the data indicates that in-situ soils have a hydraulic conductivity between 1.4E-03 and 9.5E-04 centimeters per second (cm/sec), while the fill surrounding the tanks has a hydraulic conductivity between 6.66E-02 and 2.5E-03 cm/sec. The hydraulic conductivity of the bedrock was between 1.0E-03 and 1.2E-04 cm/sec (Table 3-1).

The hydraulic conductivity of the bedrock and natural soils surrounding higher conductivity fill materials may impede the flow of free product and groundwater from petroleum-impacted fill materials to bedrock and in-situ soils downgradient of the tank. The degree of effectiveness of this partial barrier may vary locally, and further investigation would be required to determine their roles.

6.3.4 Saturated Thickness

The area of investigation is dominated by the presence of the large UST (36-feet high by 119-feet in diameter) and an excavation backfilled with material of widely varying porosity that extends approximately 19.6 feet below the original bedrock surface. The saturated thickness of the aquifer in the unconsolidated materials is therefore a function of the location of the tank socket.

Using December 1995 groundwater levels measured in MW-122, the depth to the water table is 19.6 feet bgs. The depth to bedrock in Boring SB-336 is approximately 20 feet below ground surface outside the socket. The saturated thickness of the aquifer outside of the tank socket area is therefore approximately 0.40 foot.

Within the socket area, the saturated thickness is greater. Based on an estimated socket depth of 40 feet, the saturated thickness of the aquifer within the socket is approximately 20.4 feet.

6.3.5 Surface Soil

Two surficial soil samples collected in an area overlying the tank were submitted for TPH analysis (Figure 6-1). The sampling objective was to evaluate the presence of petroleum-impacted soils overlying the roof of Tank 45. The sample locations were selected to evaluate soils in areas of the tank that would be impacted in the event of an overfill at the tank. Samples were collected at the tank manway and vent. No overfills were documented at the tank.

Analytical results indicate TPH was not detected at SS-02, collected 2 to 6 feet in front of the tank man-way. The TPH concentration was below detection limits in sample SS-01, collected 2 to 6 feet beside the vent. Analytical results are presented in Table 6-6.

TABLE 6-6
TPH IN SURFACE SOIL
TANK 45, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

SAMPLE ID	DEPTH SAMPLED	CONCENTRATION (mg/kg)	EXCEEDS GUIDANCE OF 2,500 mg/kg (YES/NO)
TK45-SS-01	01-02	ND[1]	No
TK45-SS-02	01-02	ND[1]	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
(1) - EPA Method 418.1

Notes:

For comparative purposes only, mg/kg unit designations and ppm unit designations were considered to be equivalent.

6.4 VOLATILE ORGANIC COMPOUND MONITORING

Preliminary Closure Assessment

PCA laboratory results indicate that VOCs are not significant components of petroleum-impacted soils or groundwater (Table 6-2). An on-site source of VOCs that would result in a release to the ambient air has not been identified.

Site Investigation

During the soil sampling task of the SI, soil samples were field screened with a FID to evaluate the presence of VOCs. Ambient air screening with a PID was also conducted as part of routine health and safety monitoring to protect site workers.

Results from both investigations indicate that no VOCs were detected in the ambient air or in soils at Tank 45.

6.5 SURFACE WATER DRAINAGE

Runoff from Tank 45 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,980 feet to the west. Most rainwater infiltrated soil and permeable fill materials, and exited the site as groundwater.

6.6 COMPARISONS TO REGULATORY STANDARDS

Laboratory analytical results were evaluated with respect to one or more of the following regulatory standards:

- Rhode Island Department of Health Lead Poisoning Prevention Standard (150 mg/kg) (RIDOH, 1992).
- U.S. EPA "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (400 ppm) (EPA, 1994a).
- U.S. EPA "Drinking Water Regulations and Health Advisories" (Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs)) (EPA, 1994b).

- RIDEM "Rules and Regulations for Groundwater Quality" (Groundwater Quality Standards and Preventative Action Limits) (RIDEM, 1993b).

- "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA Groundwater Protection Standard) (EPA, 1991).

Regulatory standards have not been established for the semi-volatile organic compounds detected in soil or groundwater. Similarly, no standards have been established for arsenic, cadmium, and chromium in soils.

The groundwater at the site is not used for potable purposes, and as such, is not subject to the provisions of the SDWA. However, lacking appropriate and relevant regulatory requirements for this medium, the SDWA MCLs for chemicals detected in groundwater are used for comparison. The RIDEM groundwater standard is applicable to groundwater classified as "GAA" or "GA". These classifications represent groundwater resources suitable for drinking water use without treatment. Groundwater beneath Tank Farm 4 has been assigned a "GB" classification, which identifies it as a groundwater resource that is not suitable for drinking water use (RIDEM, 1993). Therefore, for "GB" classified groundwater, the RIDEM standard does not apply. It is also being used for comparative purposes only.

Arsenic, barium, chromium, lead, mercury, and silver in the MW-122 groundwater sample were evaluated with respect to MCLs and RIDEM groundwater standards (RIDEM, 1993; U.S. EPA, 1994b). These metals exceed both groundwater standards, as shown in Table 6-2. Exceptionally high turbidity levels in groundwater may have contributed to the elevated concentrations of metals, which typically are adsorbed to particulates drawn into the well during the sampling process (Puls and Powell, 1992).

Arsenic, barium, chromium lead, mercury, and silver in groundwater were also compared to RCRA groundwater protection standards. These standards are designed to ensure that hazardous constituents detected in the groundwater from a regulated unit do not exceed specified concentration limits. The MW-122 sample concentration for barium exceeds the RCRA groundwater protection standards.

6.6.1 TPH Clean-up Levels

TPH clean-up levels are identified to develop remedies to protect human health and the environment and to ensure that the selected remedial alternative will properly address concerns at the site. Two objectives were considered in developing clean-up levels at Tank Farm 4 and these levels will be used to select appropriate future actions at the tank farm. The objectives are:

- Protect human health from risks on site associated with ingestion of, inhalation of, and dermal contact with impacted soils

- Protect human health and the environment by controlling any off-site migration of contaminated groundwater (although no significant migration has occurred)

RIDEM has established guidance concentrations of TPH in soils that specifically apply to using excavated soil as backfill material following UST removal. RIDEM generally establishes UST related soil and groundwater clean-up criteria on a case-by-case basis considering potential off-site migration of impacted groundwater, and the presence of site-specific potential human and ecological receptors.

6.6.1.1 Exposure Routes

A significant objective of a clean-up level is to minimize the effects of chemicals to human and environmental receptors. Potential exposure routes of impacted soils to humans include ingestion, dermal contact, and inhalation of fugitive dust from surface soils. Because most impacted soils are located beneath a minimum of 30 feet of "unimpacted" soils, these exposure pathways do not present a significant risk to humans at the site surface.

Several exposure pathways that have been identified through pathway modeling (B&R Environmental, 1996) include dermal contact of impacted soils by a construction worker who may be exposed during excavation activities or ingestion of small quantities of soil by workers or trespassers.

Potential inhalation of VOCs is not considered an exposure pathway at the site. No VOCs were detected in ambient air during health and safety monitoring conducted during site investigation field work. Sampling and analysis of soils during the PCA confirmed the absence of VOCs in impacted site soils and groundwater.

Ingestion of groundwater is not considered a potential exposure pathway because local groundwater resources are classified as a type "GB" aquifer (Code of Rhode Island Rules Number 12-100-006, Section 9 and Appendix II), which is not suitable for drinking. Also, Tank Farm 4 is not located within a groundwater reservoir or groundwater recharge area (Code of Rhode Island Rules Number 12-100-006, Appendix III and IV) and no public or private water supply wells are located downgradient of the farm. The only potential pathway of human exposure to petroleum-impacted groundwater is through dermal contact at areas of groundwater discharge to surface water bodies. Runoff from Tank 45 drains westerly through moderately developed surface water drainage features to Narragansett Bay, approximately 1,980 feet to the west. Studies conducted during the Tank 50 SI have indicated that the mobility of the petroleum constituents in groundwater is minimal, even in areas where TPH in soil exceeds 10,000 mg/kg (B&R Environmental, 1995b). Therefore, the potential for human exposure to impacted groundwater is considered low.

Pathway modeling was conducted to identify potential exposures of ecological receptors at Tank 50, Tank Farm 5. The results of the modeling were presented in the Technology Screening Evaluation (B&R Environmental, 1996). The model can generally be applied to Tank 45, because tank construction methods are similar, and land development in the downgradient direction from Tank 45 is similar to areas downgradient of Tank 50. Results of the modeling indicated that no complete pathways exist for migration of impacted media to ecological receptors.

6.6.1.2 Proposed Clean-up Levels

RIDEM has a policy of establishing site-specific TPH clean-up levels. TPH concentrations in soil of 2,500 mg/kg and 5,000 mg/kg will be proposed by the Navy as clean-up levels at Tank 45. These concentrations are considered conservative and were adopted as soil clean-up standards by Massachusetts and published as part of the MCP in November, 1993 (MADEP, 1993) and are not legally binding in Rhode Island.

These soil standards were established based on the characterization of risk posed by petroleum-impacted disposal sites. The MCP and various guidance and policy documents issued by the MADEP describe the documentation of site risk. Both groundwater usage (310 CMR:40.0931 and 40.0932) and accessibility to soil (310 CMR 40.0931 and 40.0933) are considered in the site risk characterization.

The proposed clean-up level of 2,500 mg/kg TPH in soil considers that soils may be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(b)), and are "potentially accessible," described as being "located at a depth of 3 - 15 feet below the surface..." (310 CMR 40.0933(4)(c)).

The proposed clean-up level of 5,000 mg/kg TPH in soil considers that soils may also be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(a)), and are "isolated," described as being "located at a depth greater than 15 feet below the surface..." (310 CMR 40.0933(4)(c)). The applicable sections of the MCP are included in Appendix E.

6.7 FUTURE ACTIONS

The following section presents recommended future actions at Tank 45. Two actions are discussed: source control and interim action.

6.7.1 Source Control

Tank contents removal and cleaning is scheduled for the summer of 1996. Product will be removed from the tank and the tank will be cleaned and closed. The tank will be inspected and closed following approval by RIDEM.

6.7.2 Interim Action

Groundwater levels are lowered to the elevation of the tank bottom during tank closure operations. The ring drain system is used to manage the groundwater level at the tank for the duration of closure activities, a period of approximately one to two months. During the pumping operations, some NAPL may be removed from the impacted fill materials in the tank socket in conjunction with groundwater withdrawal. This pumping action may result in removing contaminant mass from the system, thereby lowering petroleum concentrations at the site.

Following the interim action, additional groundwater and subsurface soil samples will be collected from zones of petroleum-impacted soil that were identified during the SI as exceeding proposed clean-up standards. Samples will be analyzed by Method 418.1, and compared to results of analyses conducted during the SI.

The need for additional remedial action will be evaluated based on the results of the interim action.

7.0 TANK 48 INVESTIGATION

Section 7.0 summarizes investigations conducted to evaluate the nature and extent of petroleum-impacted soils and groundwater, and effects to human health and the environment at Tank 48. The PCA evaluated the impacts to soil and groundwater of past petroleum storage and handling practices at each of the Tank Farm 4 and 5 USTs, including Tank 48. Results of the PCA indicated the need for conducting a site investigation at Tank 48.

Preliminary Closure Assessment

Specific soil and groundwater sampling methods, and soil boring and monitoring well construction techniques are described in detail in the final Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5, dated September 1994 (HNUS, 1994). Additional RIDEM comments, which addressed initiating soil sampling at the water table, and containerizing all IDW were conveyed to the B&R Project Manager and the NETC representative (personal communication).

GPR and utility location surveys were conducted by a subcontractor to B&R Environmental to identify the UST edges and associated piping to facilitate the borehole placement.

The PCA field investigation was conducted by B&R Environmental from October to December 1994. The objective of the study was to evaluate the impacts of past site activities on soil and groundwater by collecting and analyzing soil and groundwater samples. The PCA involved advancing one soil boring (B-48), and subsequently installing a groundwater monitoring well, MW-119, in the boring on the hydraulically downgradient side of Tank 48.

Soil sampling was initiated at 25 feet bgs (estimated depth of the water table) and continued to the end of the boring, approximately 40 feet bgs. Soil cuttings and air samples at each borehole were monitored with PIDs and FIDS. Visual and olfactory evidence of the presence of petroleum was noted on boring logs.

Selected soil samples were screened with an Ensys immunoassay kit for the presence of TPH. The sample that exhibited the highest concentration of petroleum components, as determined by immunoassay results, was generally selected for laboratory analysis. Soil samples selected for laboratory analysis were analyzed by EPA methods for volatile and semi-volatile organic compounds, TPH, and the eight RCRA metals. Groundwater samples were analyzed for the above parameters, with the exception of TPH. The objective of the soil boring and groundwater monitoring well is summarized in Table 7-1.

Three soil probings, P-1, P-2, and P-3 were also advanced on the hydraulically downgradient side of the shunt piping run at Tank 48 to evaluate the presence of petroleum-impacted soil. The probings were performed using a combination of standard solid-stem auger methods advancing a 2.5-inch diameter drive point, and advancing an open hole with a split-spoon sampler. Two split-spoon samples were then obtained from 4 to 6 and 6 to 8 feet bgs. A review of the best available data determined that the piping lay no deeper than 5 feet bgs. Later work and investigations at Tank Farm 5 indicated that the piping is located 6 to 8 feet bgs (Jalkut, 1995b). The soil samples were screened using the Ensys Petro Risc immunoassay kit for the presence of petroleum hydrocarbons, and the sample exhibiting the highest concentration of petroleum in each probing was submitted for laboratory analysis. Probing field logs are presented in Appendix B.

<u>Site Investigation</u>

The SI was conducted between November and December 1995, and focused on delineating the extent of TPH in soil and groundwater. During the SI field effort, 13 soil borings were advanced and two surface soil samples were collected (Figure 7-1). Of the 13 soil borings, seven, SB-401, SB-404, SB-408, SB-409, SB-412, SB-421 and SB-422 were advanced through the unconsolidated overburden, and completed as groundwater monitoring wells, MW-401, MW-404, MW-408, MW-409, MW-412, MW-421, and MW-422.

In SB-401, split-barrel soil sampling was initiated at the ground surface and continued to refusal in order to define the vertical extent of petroleum-impacted soils. In the remainder of the borings, samples were collected at standard intervals (5-foot intervals) from the ground surface to the water table, and continuously from the water table to the end of the boring at refusal.

Borings SB-401, SB-404, SB-408, and SB-412 were advanced within the bedrock socket and completed as monitoring wells. Boring SB-409 was advanced outside the bedrock socket and was completed as a monitoring well after petroleum-impacted soil was noted from 22 to 23 feet bgs. SB-421 was completed as a downgradient monitoring well approximately 70 feet from Tank 48. MW-422 was installed in the former location of the tank access ramp.

TABLE 7-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
B-48/(MW-119)	PCA	Downgradient of Tank 48; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples. Provide a data point for aquifer characterization.
SB-401/(MW-401)	SI	Crossgradient of Tank 48; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
SB-404/(MW-404)	SI	Crossgradient of Tank 48; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples.
SB-408/(MW-408)	SI	Upgradient of Tank 48; within area of socket.	NA	Provide data on presence of TPH impacted soils; provide sampes for engineering parameters.	Provide groundwater samples. Provide a data point for aquifer characterization.
SB-409/(MW-409)	SI	Downgradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples. Provide a data point for aquifer characterization.
SB-412/(MW-412)	SI	Downgradient of Tank 48; within area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples.
SB-414	SI	Down- and cross- gradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
SB-419	SI	Downgradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
SB-420	SI	Downgradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
SB-421/(MW-421)	SI	Down- and cross- gradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples. Provide a data point for aquifer characterization.

TABLE 7-1
SUMMARY OF SURFACE SOIL SAMPLES, SOIL BORINGS, AND MONITORING WELLS
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 2

BORING/WELL/ SAMPLE NO.	FIELD EVENT	LOCATION	PURPOSE OF SURFACE SOIL SAMPLES	PURPOSE OF SOIL BORING	PURPOSE OF WELL
SB-422/(MW-422)	SI	Crossgradient of Tank 48; within area of socket ramp.	NA	Provide data on presence of TPH impacted soils.	Provide groundwater samples. Provide a data point for aquifer characterization.
SB-423	SI	Downgradient of Tank 48; outside area of socket.	NA	Provide data on presence of TPH impacted soils.	NA
MW-424	SI	Downgradient of Tank 48; outside area of socket; Bedrock well	NA	Provide data on presence of TPH impacted soils and bedrock.	Provide groundwater samples. Provide a data point for aquifer characterization.
SB-425/(MW-425)	SI	Downgradient of Tank 48; outside area of socket; Bedrock well	NA	Provide data on presence of TPH impacted bedrock.	Provide groundwater samples. Provide a data point for aquifer characterization.
P-1	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
P-2	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
P-3	PCA	Downgradient of shunt piping.	NA	Provide data on presence of TPH impacted soils.	NA
SS-01	SI	Top of Tank 51 roof - east side, near former location of small manway.	Provide data on presence of TPH impacted soils above the tank lid.	NA	NA
SS-02	SI	Top of Tank 51 roof - west side, near large manway with door.	Provide data on presence of TPH impacted soils above the tank roof.	NA	NA

Legend:

PCA - Closure Assessment
SI - Site Investigation
NA - Not Applicable

LEGEND

48-SB419 — SOIL BORING LOCATION WITH IDENTIFIER

48-MW425 — MONITORING WELL LOCATION WITH IDENTIFIER

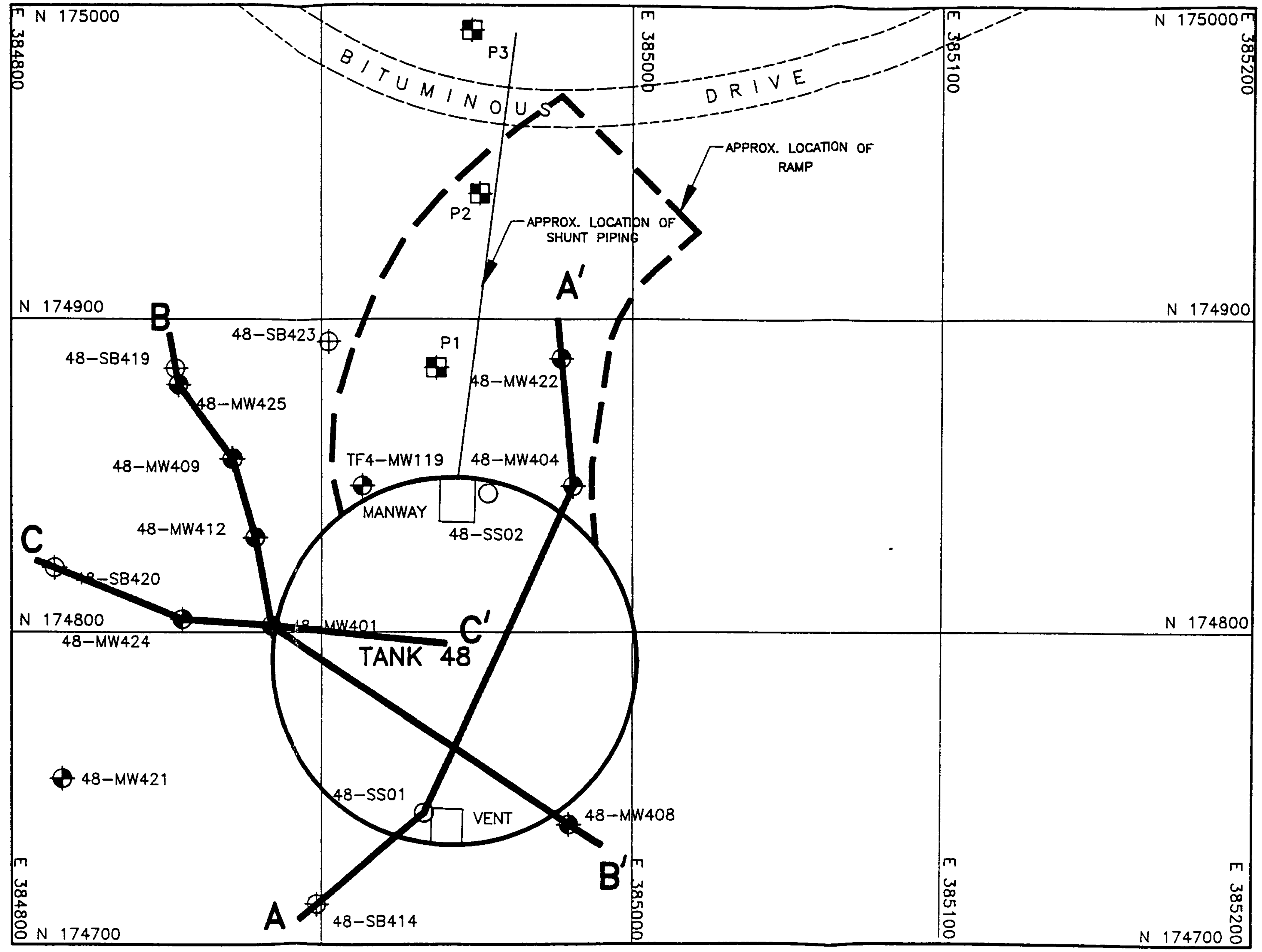
48-SS02 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

P1 — SOIL PROBING SAMPLE LOCATION WITH IDENTIFIER

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET



NOTES:

1) PLAN NOT TO BE USED FOR DESIGN.

2) LOCATIONS FROM BASE MAP BY LOUIS FEDERICI & ASSOCIATES, 235 PROMENADE STREET, PROVIDENCE, RI.

3) GRID COORDINATES BASED ON THE STATE OF RHODE ISLAND GRID COORDINATE SYSTEM (NAD 1983).

CROSS-SECTION LOCUS PLAN – TANK 48				FIGURE 7-1
NETC-NEWPORT, RI				Brown & Root Environmental
SITE INVESTIGATION REPORT – TANK FARM 4				A Division of Halliburton NUS Corporation
DRAWN BY:	R.G. DEWSNAP	REV.:	0	55 Jonspin Road Wilmington, MA 01887
CHECKED BY:	J.B. HOLDEN	DATE:	22 FEB 96	(508)658-7899
SCALE:	1" = 40'	FILE NO.: D:\DWG\NETC\SI-38-48\FIG_7-1		

W5296104F

Four soil borings, SB-414, SB-419, SB-420, and SB-423, were advanced to investigate downgradient migration of petroleum and collect soil samples outside the socket through the unconsolidated overburden. They were then backfilled.

Two borings, SB-424 and SB-425, were advanced outside the socket 20 feet into bedrock. These borings were completed as bedrock monitoring wells, MW-424 and MW-425. MW-425 was advanced approximately 2 feet from SB-419, and no soil samples were collected.

Soil boring and well construction logs are presented in Appendix B and C, respectively. Analytical data is reported in Appendix D. The objective of each soil boring and groundwater monitoring well is summarized in Table 7-1.

7.1 ANALYTICAL METHODS

The following section summarizes analytical methods and results of work conducted during the PCA and the SI.

EPA-approved laboratory methods were used to evaluate soil and groundwater samples at the site. Detailed descriptions of specific field procedures and analytical methods are presented in the "Work Plan - Preliminary Closure Assessments of Tank Farms 4 and 5", dated September 1994 (HNUS, 1994), with Addendum 1 (HNUS, 1995c), and Addendum 2 (HNUS, 1995e).

Throughout each investigation, soil and groundwater samples were collected and analyzed according to Naval Facilities Engineering Service Center (NFESC) requirements. All environmental samples collected as part of these investigations, including QC samples, were stored and shipped in accordance with chain-of-custody procedures outlined in the project-specific Quality Assurance/Quality Control Plan, prepared as part of the Work Plan.

7.1.1 Field Screening

Preliminary Closure Assessment

Because Tank 48 had been used to store virgin No. 6 fuel oil and possibly No. 2 fuel oil, environmental media were analyzed for parameters typically associated with petroleum components. During the PCA investigation, soil samples were visually inspected for the presence of petroleum, and were screened with PIDs and FIDS, and an Ensys Petro Risc immunoassay kit. Generally, PIDs were used for health and safety screening for VOCs, while FIDs were used for soil screening for VOCs and SVOCs. Visually impacted soils were not Ensys screened. Results of Ensys TPH screening were confirmed by laboratory analysis.

Site Investigation

During the SI investigation, soil samples were visually inspected for the presence of petroleum and screened with FIDS. Results of TPH screening were confirmed by laboratory analysis.

7.1.2 Laboratory Analysis

Preliminary Closure Assessment

During the PCA, sample analyses were conducted by Ceimic Laboratories of Narragansett, Rhode Island. Ceimic is a NFESC-approved laboratory.

EPA-approved analytical methods were used for laboratory analyses. Soil samples were analyzed for TCL volatile organic compounds (Method SW-846 8240); TCL semi-volatile organic compounds (Method SW-846 8270); and RCRA metals (Method SOW ILMO 3.0) to evaluate potential impacts to soil from sludge pits reported to exist on site. TPH extractables (Method SW-846 8015) were analyzed to evaluate potential impacts of releases of petroleum from USTs to soil. Groundwater samples were not analyzed for TPH, but otherwise were analyzed for the same parameters.

Site Investigation

Samples collected and analyzed during the SI were analyzed for TPH (Method SW-846 418.1). Soil samples were also analyzed for several engineering parameters that will be used to evaluate potential remedial alternatives. Parameters and analytical methods include: grainsize (ASTM D421/422), moisture content (ASTM 2216), heterotrophic plate count (SM 9215 modified), sediment oxygen demand (modified BOD Method SM 5210B), chemical oxygen demand (E 410.1 modified), total phosphorus (E 365.4 modified), nitrate (SW 9200), and total organic carbon (TOC-SW/9060). TPH and most engineering analyses were conducted by Ceimic, heterotrophic plate count by Lancaster Laboratories, and grainsize by Geotechnics. Laboratory analytical results are presented in Appendix D.

TPH extractables were analyzed during the PCA using Method 8015 to identify a petroleum fingerprint. During the SI, TPH was analyzed using Method 418.1 because the Rhode Island action level guidance is based on Method 418.1. Analysis conducted during the PCA indicated minimal concentrations of VOCs in soil and groundwater. Soils present within the investigation areas are organic-poor mineral soils. Method 418.1 analyzes the total number of carbon-hydrogen bonds in a sample, while Method 8015 is specific to petroleum hydrocarbons. The low organic characteristics of a mineral soil minimizes the potential for interference caused by elevated levels of organic compounds when using Method 418.1. Samples analyzed using Method 418.1 are therefore, considered roughly comparable to samples analyzed using Method 8015.

7.2 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE PRELIMINARY CLOSURE ASSESSMENT

MW-119 was installed as part of the PCA field investigation and is located hydraulically downgradient of Tank 48, approximately 5 feet from its perimeter (Figure 7-1). The well screen was set 33.5 to 38.5 feet bgs to correspond with an interval of coarse-grained fill material that was interpreted as part of the ring drain. The interval was petroleum-impacted; NAPL commonly saturated coarse-grained fill materials.

The upper 25 feet of the boring were not examined. Soil sampling was initiated at 25 feet based on historical data indicating that the water table was approximately 25 feet bgs. It was presumed that petroleum releases above the water table would migrate vertically downward and be detected in soil and possibly groundwater. Soil sampling was continuous from 25 feet bgs to refusal, at approximately 39.7 feet bgs. Fill material from 27 feet bgs to refusal (interpreted as the bedrock surface) was heavily impacted by petroleum and NAPL was observed saturating coarse grained fill materials. PID responses ranged from less than 3.7 ppm to 15.0 ppm. Fill material was comprised of sandy silt (25 to 27 feet bgs), sandy gravelly silt (27 to 31 feet bgs), silty gravel (31 to 37 feet bgs), and coarse gravel (37.0 to 39.5 feet bgs).

Dark gray phyllite was observed at refusal approximately 39.7 feet bgs, and the boring was terminated. The boring log is presented in Appendix B.

On November 29, 1994, the depth to the water table was 15.49 feet bgs as measured in MW-119. Seasonal and precipitation effects on groundwater levels were not evaluated at the site.

7.2.1 Analytical Data Summary

The PCA subsurface investigation included soil sampling during the advancement of MW-119 (B-48) and subsequent groundwater sample collection and analysis. Investigations conducted during the PCA focused on determining the nature of impacted soil and groundwater.

During the PCA, two subsurface soil samples (B482729 and B483941) were selected for laboratory analysis from B-48 (MW-119), located near Tank 48. These samples were collected from depths of 27 to 29 feet bgs, and 39.0 to 39.7 feet bgs, and consisted of sandy gravelly silt, and gravel with minor amounts of silt and sand. Both subsurface soil samples were heavily impacted with petroleum. Following standard well development and well purging procedures, a groundwater sample was collected from the midpoint of the well screen, approximately 36.5 feet bgs. Immiscible oil droplets were observed in the groundwater sample.

Three subsurface soil samples were selected for analysis from the soil probings downgradient of the shunt piping for Tank 48. Two of these samples were collected from depths of 6 to 8 feet bgs (samples P-1-48-0608 and P-2-48-0608), and one from a depth of 4 to 6 feet bgs (sample P-3-48-0406). Samples P-1, P-2, and P-3 consisted of sandy silt.

Positive organic and inorganic analytes detected in soil and groundwater are reported in Table 7-2. Complete laboratory analytical results are reported in Appendix D.

7.2.1.1 Subsurface Soils in the Tank Socket

Volatile Organic Compounds (VOCs)

Benzene was detected at a concentration of 260 μg/kg in subsurface soil sample B482729. Benzene is a common organic compound identified in fuel oil (Dragun, 1988). No other volatile organic compounds were present above detection limits in this subsurface soil sample. No volatile organic compounds were present above detection limits in subsurface soil sample B483941.

Semi-Volatile Organic Compounds (SVOCs)

Sixteen semi-volatile organic compounds ranging in concentration from 43 μg/kg to 1,400 μg/kg were detected in subsurface soil samples B482729 and B483941. 2-methylnaphthalene, acenaphthene, dibenzofuran, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene,

TABLE 7-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-48	27-29	Benzene	260 μg/kg	None	N/A
Soil	B-48	27-29	2-Methylnaphthalene	1200 μg/kg	None	N/A
Soil	B-48	27-29	Acenaphthene	290 μg/kg	None	N/A
Soil	B-48	27-29	Dibenzofuran	210 μg/kg	None	N/A
Soil	B-48	27-29	Fluorene	570 μg/kg	None	N/A
Soil	B-48	27-29	N-Nitrosodiphenylamine	1100 μg/kg	None	N/A
Soil	B-48	27-29	Phenanthrene	1400 μg/kg	None	N/A
Soil	B-48	27-29	Anthracene	340 μg/kg	None	N/A
Soil	B-48	27-29	Fluoranthene	120 μg/kg	None	N/A
Soil	B-48	27-29	Pyrene	1200 μg/kg	None	N/A
Soil	B-48	27-29	Benzo(a)anthracene	99 μg/kg	None	N/A
Soil	B-48	27-29	Chrysene	150 μg/kg	None	N/A
Soil	B-48	27-29	Bis(2-ethyhexyl)phthalate	84 μg/kg	None	N/A
Soil	B-48	27-29	Benzo(a)pyrene	76 μg/kg	None	N/A
Soil	B-48	27-29	Benzo(g,h,i)perylene	61 μg/kg	None	N/A
Soil	B-48	27-29	Arsenic	10.4 mg/kg	None	N/A

W5296104F

TABLE 7-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 4

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-48	27-29	Barium	11.5 mg/kg	None	N/A
Soil	B-48	27-29	Cadmium	1.8 mg/kg	None	N/A
Soil	B-48	27-29	Chromium	12.6 mg/kg	None	N/A
Soil	B-48	27-29	Lead	9.0 mg/kg	150 ppm (4) 400 ppm (5)	No
Soil	B-48	39-41	2-Methylnaphthalene	72 µg/kg	None	N/A
Soil	B-48	39-41	Acenapthylene	43 µg/kg	None	N/A
Soil	B-48	39-41	Acenaphthene	110 µg/kg	None	N/A
Soil	B-48	39-41	Dibenzofuran	100 µg/kg	None	N/A
Soil	B-48	39-41	Fluorene	240 µg/kg	None	N/A
Soil	B-48	39-41	Phenanthrene	590 µg/kg	None	N/A
Soil	B-48	39-41	Anthracene	290 µg/kg	None	N/A
Soil	B-48	39-41	Fluoranthene	93 µg/kg	None	N/A
Soil	B-48	39-41	Pyrene	1300 µg/kg	None	N/A
Soil	B-48	39-41	Benzo(a)anthracene	92 µg/kg	None	N/A
Soil	B-48	39-41	Chrysene	160 µg/kg	None	N/A
Soil	B-48	39-41	Bis(2-ethylhexyl)phthalate	640 µg/kg	None	N/A
Soil	B-48	39-41	Benzo(a)pyrene	79 µg/kg	None	N/A
Soil	B-48	39-41	Indeno(1,2,3-cd)pyrene	45 µg/kg	None	N/A

TABLE 7-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND
PAGE 3 OF 4

MEDIA	BORING NO. OR WELL NO.	DEPTH OR SCREEN INTERVAL	ANALYTE	CONCENTRATION	REGULATORY STANDARD(S)	EXCEEDS STANDARD(S) (YES/NO)(1)
Soil	B-48	39-41	Benzo(g,h,i)perylene	64 μg/kg	None	N/A
Soil	B-48	39-41	Arsenic	10.6 mg/kg	None	N/A
Soil	B-48	39-41	Barium	11.5 mg/kg	None	N/A
Soil	B-48	39-41	Cadmium	1.7 mg/kg	None	N/A
Soil	B-48	39-41	Chromium	15.1 mg/kg	None	N/A
Soil	B-48	39-41	Lead	6.1 mg/kg	150 ppm (4) 400 ppm (5)	No
Groundwater	MW-119	33.5-38.5	Naphthalene	1 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	2-Methylnaphthalene	7 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	Dibenzofuran	1 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	Fluorene	2 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	Phenanthrene	3 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	Pyrene	2 μg/L	None	N/A
Groundwater	MW-119	33.5-38.5	Mercury	0.42 μg/L	2 μg/L (2), (3), (6)	No

Legend:

ppm - parts per million
μg/L - micrograms per liter
mg/kg - milligrams per kilogram
μg/kg - micrograms per kilogram
N/A - Not Applicable

W5296104F

TABLE 7-2
POSITIVE ORGANIC AND INORGANIC ANALYTES DETECTED IN SOIL AND GROUNDWATER
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Notes:

(1) Comparisons to Regulatory Standards and Guidelines are discussed in Section 7.6.

(2) U.S. EPA Drinking Water Regulations and Health Advisories, EPA 822-R-94-001, May 1994.

(3) State of Rhode Island Department of Environmental Management, Rules No. 12-100-006, Rule and Regulations for Groundwater Quality, Section 10, July 1993.

(4) Rhode Island Department of Health - Environmental Lead Program, [R23-24.6-PB], Rules and Regulations for Lead Poisoning Prevention, February 1992 (with amendments).

(5) OSWER Directive 9355.4-12- Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilitites.

(6) 40 CFR Part 264 - Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart F, Sections 264.92 - 264.94, July 1991.

- MW-119 was installed in boring location B-48.
- Analytical results of duplicate samples were averaged.

benzo(a)pyrene, benzo(g,h,i)perylene, and bis(2-ethylhexyl)phthalate were detected in both samples, at concentrations ranging from 61 μg/kg to 1,400 μg/kg. N-nitrosodiphenylamine was detected in subsurface soil sample B482729 at a concentration of 1,100 μg/kg. Acenaphthylene and indeno(1,2,3cd)perylene were detected in subsurface soil sample B483941 at concentrations of 43 μg/kg and 45 μg/kg, respectively.

Except for dibenzofuran, bis(2-ethylhexyl)phthalate, and N-nitrosodiphenylamine, the other compounds are PAHs commonly associated with fuel oil (Dragun, 1988).

Dibenzofuran is also a derivative of coal tar (Morrison and Boyd, 1983; Sax and Lewis, 1987). N-nitrosodiphenylamine has been used in the rubber industry as a vulcanizing retarder (Clayton and Clayton, 1981). The source of this compound at the site has not been determined. Bis(2-ethylhexyl)phthalate is a compound typically used as a plasticizer in manufacturing PVC and other plastics (Howard, 1989; Sittig, 1981), including plastics used in analytical laboratories.

<u>RCRA 8 Metals</u>

Arsenic, barium, cadmium, chromium, and lead were detected in both subsurface soil samples collected from boring B-48. Concentrations ranged from 1.7 to 15.1 mg/kg. These metals are constituents of naturally occurring soils, however, the source of these analytes has not been determined.

<u>Total Petroleum Hydrocarbons (TPH)</u>

TPH concentrations of 3,000 to 5,300 mg/kg were detected by laboratory analysis (Method 8015) in subsurface soil samples B493941 and B482729, respectively. The petroleum was identified as bunker oil. Field screening for TPH was not conducted due to the observed petroleum in the soil.

7.2.1.2 Groundwater in the Tank Socket

<u>Volatile Organic Compounds (VOCs)</u>

No volatile organic compounds were present above detection limits in the groundwater sample collected from MW-119.

Semi-Volatile Organic Compounds (SVOCs)

Six semi-volatile organic compounds, ranging in concentration from 1 μg/L to 7 μg/L were detected in the MW-119 groundwater sample. These compounds included: naphthalene, 2-methylnaphthalene, dibenzofuran, fluorene, phenanthrene, and pyrene.

RCRA 8 Metals

Mercury was detected at a concentration of 0.42 μg/L in the groundwater sample collected from MW-119. The source of this analyte may be a result of elevated turbidity in the groundwater sample. Metals typically are adsorbed onto silt and clay sized suspended particulates (Puls and Powell, 1992). These particulates are usually removed from formation materials in the vicinity of the well by developing the well.

The migration of silt and clay into a well is further minimized by a properly sized filter pack and well screen. At the direction of RIDEM, a 0.020 inch slot size screen section was installed in wells located within zones containing NAPL. This size screen aperture requires a larger sized filter pack, which is too large to retain the high silt and clay content of the fill materials in which the well is screened. The finer formation materials will continue to enter the well screen. The purpose of installing a relatively large screen aperture was to ensure that NAPL could enter the well so that the presence of NAPL could be evaluated. The 0.020 inch screen aperture size does allow the entry of NAPL into wells at the site.

7.2.1.3 Shunt Piping

Total Petroleum Hydrocarbons (TPH)

Two subsurface soil samples were collected for TPH immunoassay field screening from each soil probe. The samples were collected from 4 to 6 feet bgs, and 6 to 8 feet bgs. TPH screening results were used to determine which samples to send for lab analysis. Field screening data tables are presented in Appendix D.

TPH was not detected by laboratory analysis (Method 8015) in the soil probing samples (Table 7-3).

7.3 FINDINGS OF INVESTIGATIONS CONDUCTED DURING THE SITE INVESTIGATION

The following section presents the findings of the SI field effort. Sampling and analysis focused on determining the extent of petroleum-impacted soils and groundwater. TPH results collected during the PCA will also be discussed here to present a comprehensive evaluation of TPH data.

Soil and groundwater samples were collected and analyzed for TPH by EPA Method 418.1. Results of TPH analyses in subsurface soils and groundwater are reported in Tables 7-3 and 7-4. Soil samples were collected for grainsize analysis, percent moisture, sediment oxygen demand (SOD) or modified biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), heterotrophic plate count, total phosphorus, and nitrate (Table 7-5). This group of soil sample analyses is termed "engineering parameters" for discussion purposes. Results of these analyses are reported here for informational purposes only. The data will be evaluated as part of the assessment of remedial technologies, presented under separate cover. Complete laboratory analytical results are presented in Appendix D.

7.3.1 Subsurface Soils

Initial subsurface investigations conducted during the PCA at Tank 48 (MW-119) indicated the presence of TPH-impacted soils (maximum concentration of 5,300 mg/kg, Table 7-3) within the tank socket at the downgradient edge of the tank. TPH impacted soils were noted approximately 27 feet bgs to the end of the boring, approximately 40 feet bgs, interpreted to be the bedrock surface. NAPL was noted throughout the impacted soils within the socket, typically saturating coarser grained soils. Petroleum also occurred as a coating on sand- and gravel-size particles in coarser grained soils.

Because soil samples submitted for laboratory analyses were homogenized over a two-foot interval, results of TPH analyses represent an average concentration of petroleum in a given sample. Petroleum-saturated coarse grained fill materials were mixed with fine grained fill materials that were minimally impacted by petroleum.

Investigations conducted during the SI focused on delineating the extent of TPH-impacted soils located during the PCA. Three soil borings were advanced adjacent to the tank, SB-401, SB-404, and SB-408, and a fourth boring (SB-412) was installed inside the socket, approximately 20 feet downgradient from the tank. These borings were finished as groundwater monitoring wells MW-401, MW-404, MW-408, and MW-412 to further delineate petroleum-impacted soils in the tank socket (Figure 7-1).

TABLE 7-3
TPH IN SUBSURFACE SOIL
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING NO.	DEPTH SAMPLED	CONCENTRATION (mg/kg)	FIELD EVENT	EXCEEDS GUIDLINE OF (YES/NO)[1]	
				2,500 mg/kg	5,000 mg/kg
B-48/(MW-119)	27-29	5,300 (Bunker Oil)[2]	PCA	NA	Yes
B-48/(MW-119)	39-41	3,000 (Bunker Oil)[2]	PCA	NA	No
P-1	6-8	ND[2]	PCA	No	NA
P-2	6-8	ND[2]	PCA	No	NA
P-3	4-6	ND[2]	PCA	No	NA
SB-401/(MW-401)	11-13	ND[3]	SI	No	NA
SB-401/(MW-401)	17-19	2,700[3]	SI	NA	No
SB-401/(MW-401)	33-35	1,400[3]	SI	NA	No
SB-404/(MW-404)	17-19	2,800[3]	SI	NA	No
SB-404/(MW-404)	35-37	4,600[3]	SI	NA	No
SB-408/(MW-408)	21-23	1,500[3]	SI	NA	No
SB-408/(MW-408)	39-41	2,100[3]	SI	NA	No
SB-409/(MW-409)	22-23	810[3]	SI	NA	No
SB-412/(MW-412)	21-22	1,300[3]	SI	NA	No
SB-414	16-18	ND[3]	SI	NA	No
SB-419	10-12	ND[3]	SI	No	NA
SB-419	20-22	ND[3]	SI	NA	No
SB-420	05-07	ND[3]	SI	No	NA
SB-420	18-19	ND[3]	SI	NA	No
SB-421/(MW-421)	05-07	45[3]	SI	No	NA
SB-421/(MW-421)	17-19	ND[3]	SI	NA	No
SB-422/(MW-422)	12-14	ND[3]	SI	No	NA
SB-422/(MW-422)	16-18	2,000[3]	SI	NA	No

TABLE 7-3
TPH IN SUBSURFACE SOIL
TANK 48, TANK FARM 5
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

BORING NO.	DEPTH SAMPLED	CONCENTRATION (mg/kg)	FIELD EVENT	EXCEEDS GUIDLINE OF (YES/NO)[1]	
				2,500 mg/kg	5,000 mg/kg
SB-422/(MW-422)	24-26	2,100[3]	SI	NA	No
SB-423	10-12	ND[3]	SI	No	NA
SB-423	20-22	2,050[3]	SI	NA	No
SB-424/(MW-424)	15-17	ND[3]	SI	NA	No
SB-419/(MW-425)	NS	NS	SI	NA	NA

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
NA - Not Applicable
NS - Not Sampled
PCA - Preliminary Closure Assessment
SI - Site Investigation
(1) - Comparison to Regulatory Standards and Guidelines are discussed in Section 7.6
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1

Notes:

- Guideline is 2,500 mg/kg for depth 3-15 ft, 5,000 mg/kg for depths greater than 15 ft.

  MW-119 was installed in boring location B-48.

- MW-425 was installed adjacent to boring location SB-419.

- Analytical results of duplicate samples were averaged.

TABLE 7-4
TPH IN GROUNDWATER
TANK 48, TANK FARM 4
DRAFT SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

Well No.	Well Screen Depth Interval (ft bgs)	TPH Concentration in Groundwater (mg/L)	TPH Concentration in Soil at Screen Interval (mg/kg)(1)	Groundwater Sample Date
MW-119	33.5-38.5	NA	3,000(2)	11/1994
MW-401	27.5-37.5	18(3)	1,400(3)	12/1995
MW-404	36-41	87(3)	4,600(3)	12/1995
MW-408	37-42	3.9(3)	2,100(3)	12/1995
MW-409	17-22	4.7(3)	810(3)	12/1995
MW-412	10-20	13.5(3)	1,300(3)	12/1995
MW-421	11-16	ND(3)	ND(3)	12/1995
MW-422	19-24	3.3(3)	2,100(3)	12/1995
MW-424	26-41	440(3)	NS(4)	12/1995
MW-425	26.5-41.5	ND(3)	NS(4)	12/1995

Legend:

mg/L - milligram per liter
ft bgs - Feet Below Ground Surface
ND - Not Detected
NA - Not Analyzed for TPH
NS - Not Sampled
(1) - The soil sample interval is coincident with or overlaps the well screen interval.
(2) - SW846 Method 8015B TPH Extractables
(3) - EPA Method 418.1
(4) - Wells screened in bedrock, therefore no soil samples were collected. NAPL was present in bedrock.

Notes:

- MW-119 was installed in boring location B-48.
- Analytical results of duplicate samples were averaged.

TABLE 7-5
SUMMARY OF ENGINEERING PARAMETERS - POSITIVE DETECTS IN SUBSURFACE SOIL SAMPLES
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC-NEWPORT, RHODE ISLAND

Boring ID	Sample Depth (ft bgs)	SOD (mg/kg)	COD (mg/kg)	TOC (mg/kg)	Nitrate-Nitrite (as N)	Total Phosphorous (as P)	Heterotrophic Plate Count (cfu/g)	Percent Moisture	Grain Size
SB-401	13-15	NA	NA	NA	NA	NA	NA	12.8	Appendix D
SB-401	17-19	673	300	6,040	2.6	285	800	NA	NA
SB-401	25-27	NA	NA	NA	NA	NA	NA	12.8	Appendix D
SB-401	33-35	268	381	11,100	9.0	7.3	10,000	NA	NA
SB-404	15-17	NA	NA	NA	NA	NA	50,000	NA	NA
SB-404	17-19	1,720	451	9,240	2.2	2.3	NA	NA	NA
SB-404	29-31	NA	NA	NA	NA	NA	NA	12.7	Appendix D
SB-408	41-43	NA	NA	NA	NA	NA	NA	5.6	Appendix D

Legend:

SOD - Sediment Oxygen Demand (Modified Biochemical Oxygen Demand Method)
COD - Chemical Oxygen Demand
TOC - Total Organic Carbon
ft bgs - feet below ground surface
mg/kg - milligram per Kilogram reported on a dry weight basis
cfu/g - colony forming units/gram
ND - Not Detected
NA - Not Analyzed

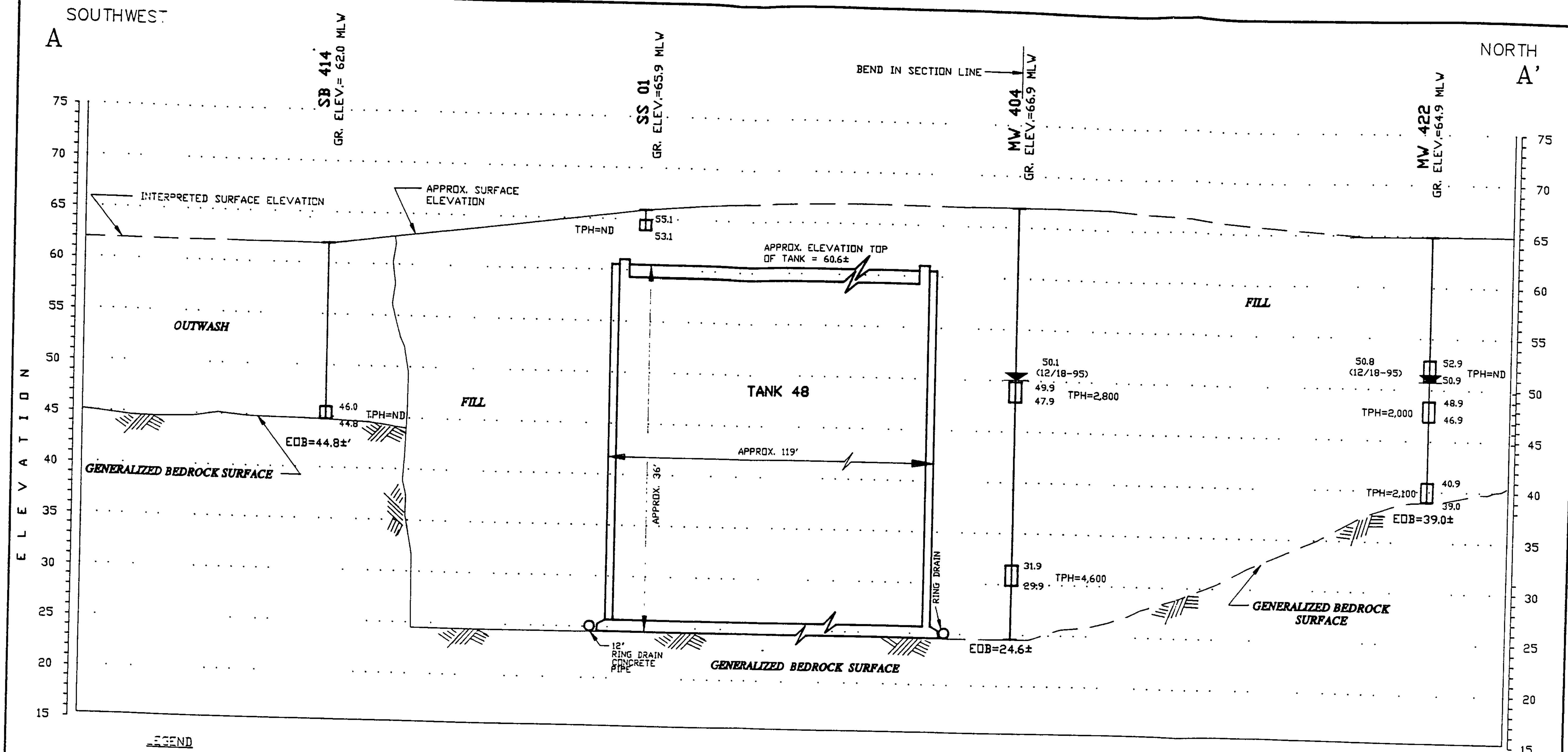
At SB-401, continuous soil samples were collected from the ground surface to the end of the boring, interpreted as bedrock, approximately 38.5 feet bgs (Figures 7-2, 7-3, and 7-4). The water table was noted at 11 feet bgs. In SB-404 and SB-412, impacted soils were noted beginning at 15 feet bgs and were continuous to refusal. NAPL was ubiquitous in this zone. The maximum TPH concentration at these borings was 4,600 mg/kg of TPH detected at 35 to 37 feet bgs in SB-404. At SB-412 a soil sample collected from 21 to 22 feet bgs (refusal) was analyzed as containing 1,300 mg/kg TPH. Petroleum-impacted soils were noted consistently within the Tank 48 socket from 21 feet bgs to refusal.

SB-422 was advanced crossgradient of the tank in the tank construction access ramp, approximately 40 feet to the north of MW-404 (Figure 7-1). In MW-422, a slight oil sheen was noted at 14 feet bgs, and visually impacted soils containing NAPL were noted from 18 feet bgs to refusal at approximately 26 feet bgs. Laboratory results indicate that TPH was not detected at 12 to 14 feet, but 2,000 mg/kg of TPH was detected at 16 to 18 feet bgs (Figure 7-2).

Numerous soil borings were advanced around Tank 48 to define the extent of petroleum impact in the overburden materials (SB-409, SB-414, SB-419 through SB-421, SB-423, and SB-424).

Soil boring SB-409 was advanced downgradient of, and approximately 40 feet from the tank. Soils collected from 22 to 23 feet bgs were petroleum-stained, and indicated a decrease in petroleum concentration, with a result of 810 mg/kg TPH. Boring SB-423 was advanced approximately 50 feet north of the tank, in the downgradient direction of the construction ramp. In SB-423, a petroleum odor was noted at 18 feet bgs, and the weathered bedrock was visually impacted from 20 feet bgs to refusal at approximately 22 feet bgs. Laboratory results indicate a TPH concentration of 2,050 mg/kg.

Petroleum was not detected in soil samples collected from borings SB-414, SB-419, SB-420, and SB-424. These borings were advanced in a hydraulically downgradient location, up to 74 feet from the tank (Figures 7-1 through 7-7). The borings were advanced to refusal, interpreted as the bedrock surface. A soil sample collected from 5 to 7 feet bgs from SB-421 was analyzed as containing 45 mg/kg TPH. This supports the theory that petroleum has migrated only a short distance through the overburden. Boring SB-421 was completed as monitoring well MW-421 to determine if TPH was migrating with groundwater away from the socket. Boring SB-424 was completed as a bedrock monitoring well (MW-424) to determine if TPH was migrating in the bedrock away from the socket. Soil samples were collected at standard intervals to 10 feet bgs, and continuously from 10 feet bgs to refusal. Boring logs are included in Appendix B, and analytical results are included in Appendix D.



LEGEND

46.9 / 44.9 TPH=5.0 — SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

50.1 (12/18-95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT

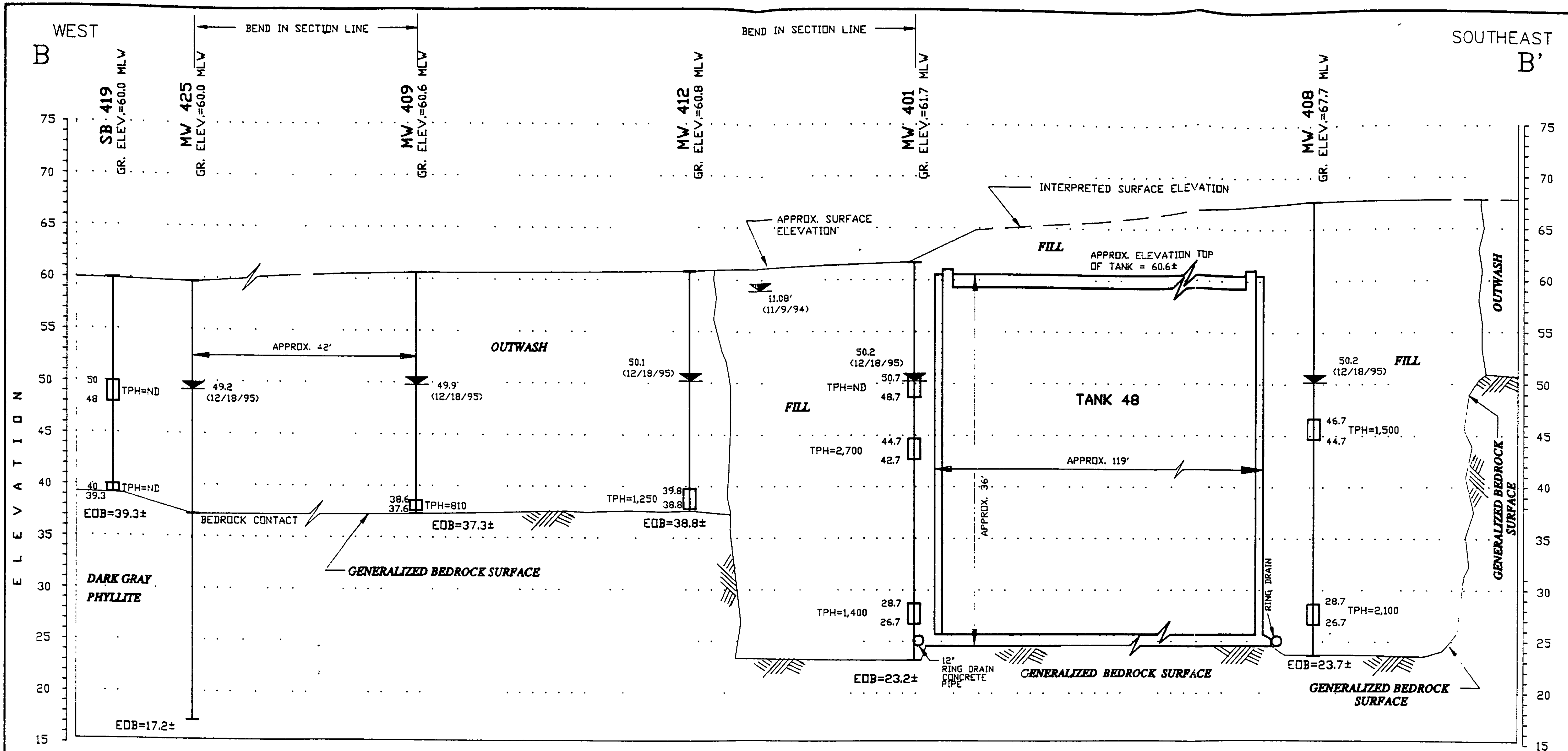
NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN SOIL

CROSS-SECTION A-A' – TANK 48				FIGURE 7-2
NETC-NEWPORT, RI				Brown & Root Environmental
SITE INVESTIGATION REPORT – TANK FARM 4				A Division of Halliburton NUS Corporation
DRAWN BY:	R.G. DEWSNAP	REV.:	0	55 Jonspin Road Wilmington, MA 01887
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96	(508)658-7899
SCALE:	1" = 10' (APPROX.)	FILE NO.:	O:\DWG\NETC\SI-38-48\XSEC48AB	

W5296104F



LEGEND

46.9 / TPH=5.0 / 44.9 — SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

49.9 (12/18/95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG)
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN SOIL

CROSS-SECTION B-B' - TANK 48

NETC-NEWPORT, RI

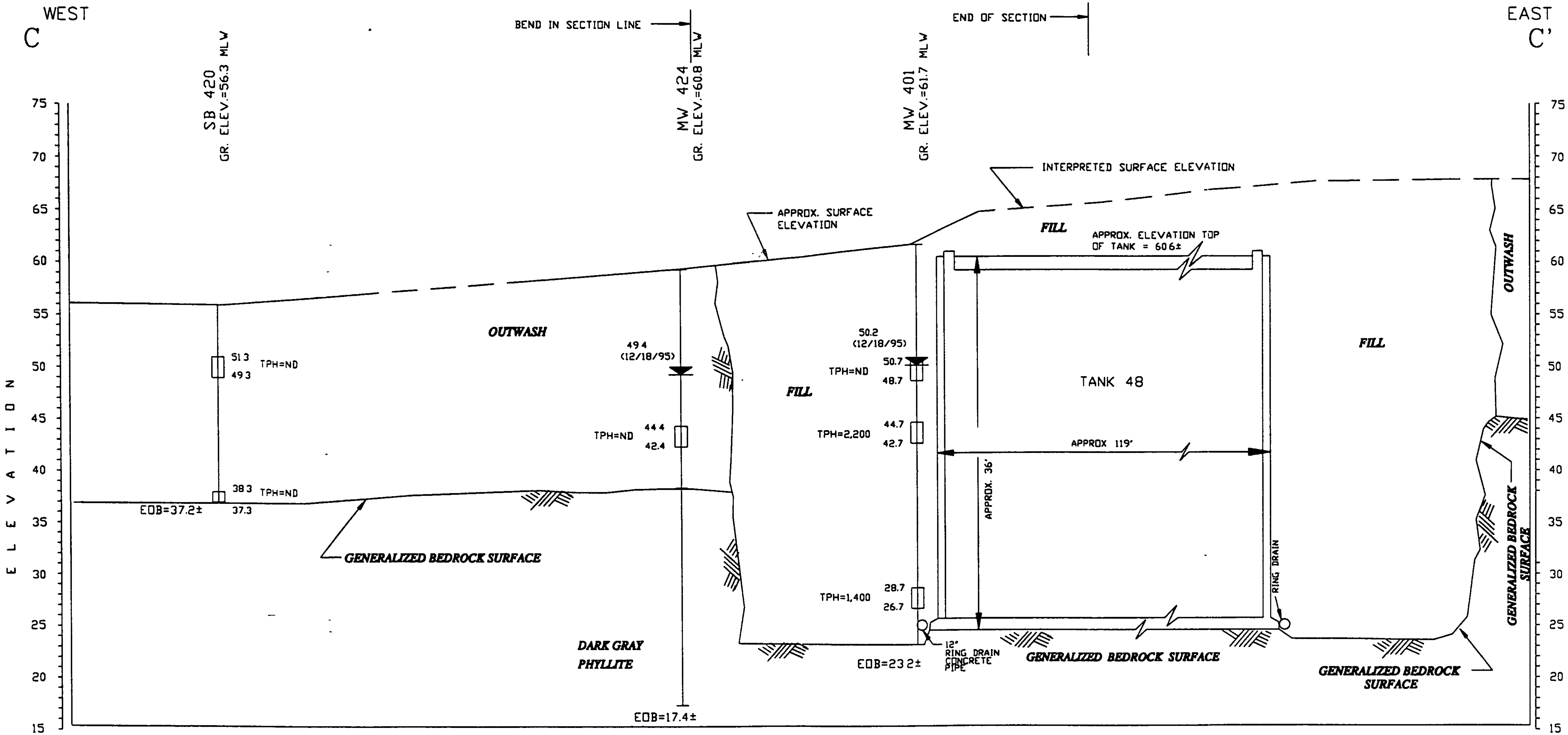
SITE INVESTIGATION REPORT - TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.:	D:\DWG\NETC\SI-38-48\XSEC488B

FIGURE 7-3

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F



LEGEND

46.9 TPH=50 44.9 — SOIL SAMPLE INTERVAL ANALYZED BY LAB WITH ELEVATION AND TPH CONCENTRATION.

49.4 (12/18/95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

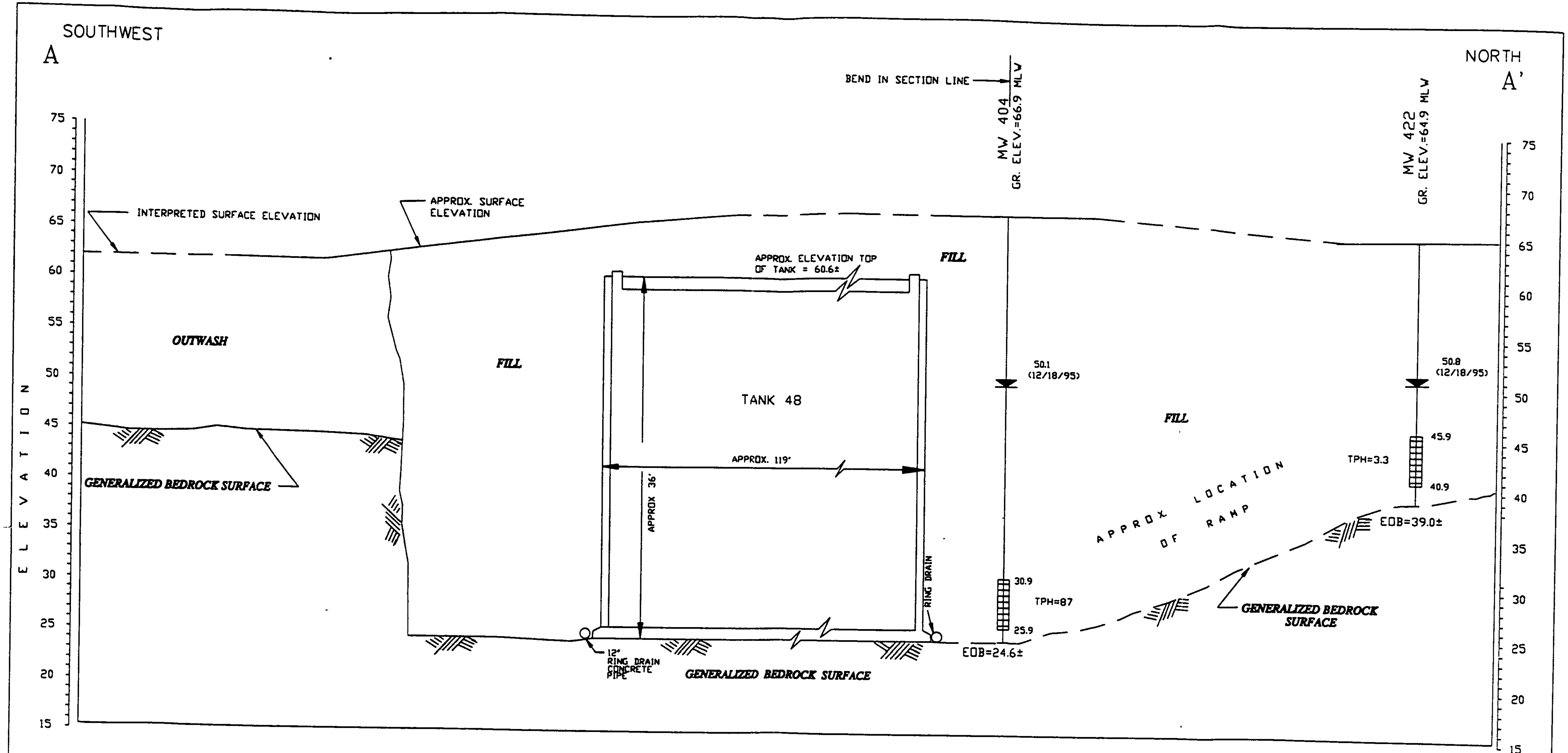
Horizontal & Vertical Scale: 1IN. = 10 FT.

NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN SOIL

CROSS-SECTION C-C' - TANK 48				FIGURE 7-4
NETC-NEWPORT, RI				Brown & Root Environmental
SITE INVESTIGATION REPORT - TANK FARM 4				A Division of Halliburton NUS Corporation
DRAWN BY:	R.G. DEWSNAP	REV:	0	55 Jonspin Road Wilmington, MA 01887
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96	(508)658-7899
SCALE:	1" = 10' (APPROX.)	FILE NO.: D:\DWG\NETC\SI-38-48\XSEC48CB		



LEGEND

46.9 / TPH=5.0 / 44.9 — WELL SCREEN INTERVAL WITH ELEVATION AND GROUNDWATER TPH CONCENTRATION.

50.8 (12/18/95) — WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)

TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN GROUNDWATER

CROSS-SECTION A-A' – TANK 48

NETC-NEWPORT, RI

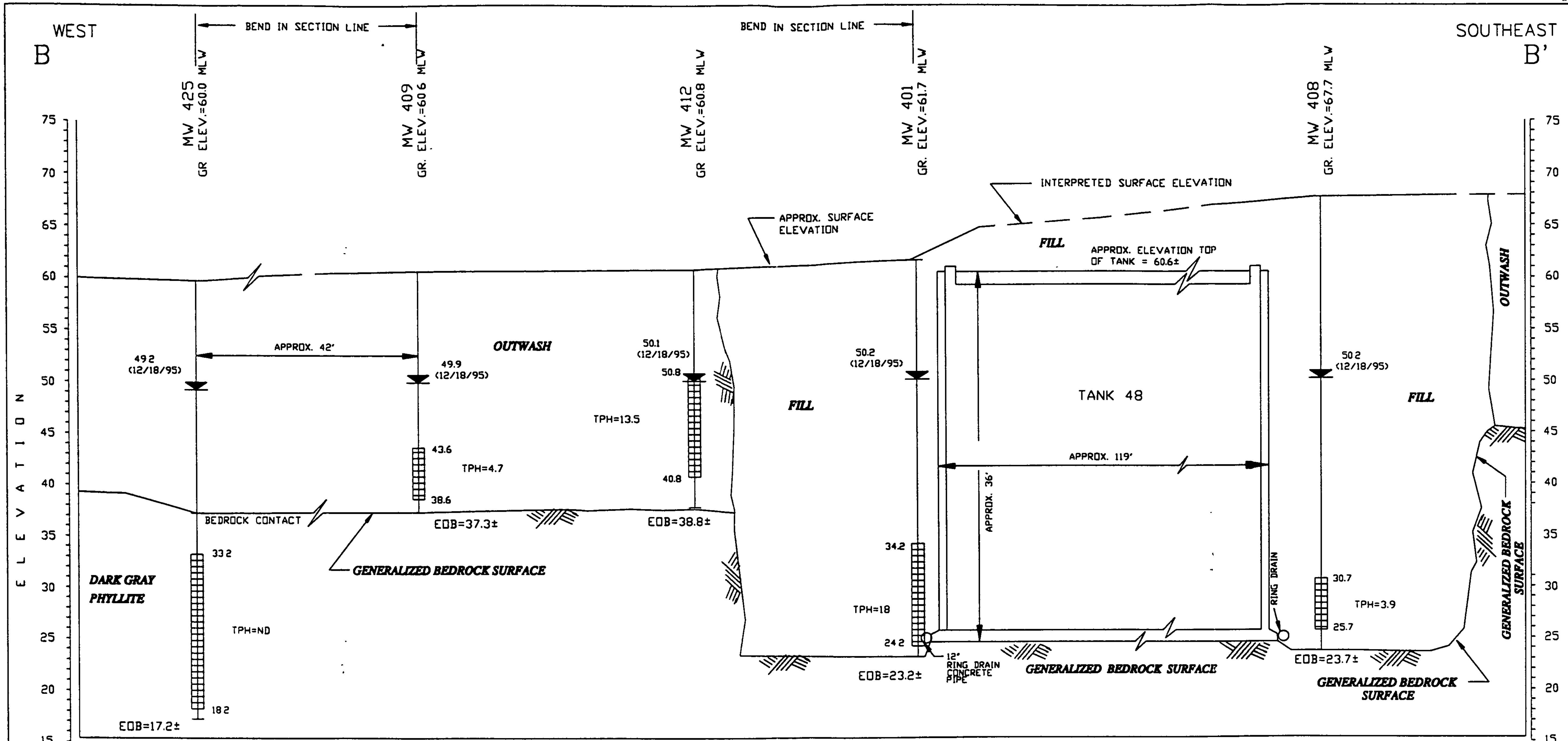
SITE INVESTIGATION REPORT – TANK FARM 4

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.: O:\DWG\NETC\SI-38-48\XSEC48AW	

FIGURE 7-5

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F



LEGEND

46.9 / TPH=5.0 / 44.9 — WELL SCREEN INTERVAL WITH ELEVATION AND GROUNDWATER TPH CONCENTRATION

50.2 (12/18/95) — WATER TABLE ELEVATION IN FEET (MWL) (DATE OBSERVED)

TPH TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103 GROUNDWATER MONITORING WELL NUMBER
SB 205 SOIL BORING NUMBER
ND NOT DETECTED
EOB END OF BORING
GR. ELEV. GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

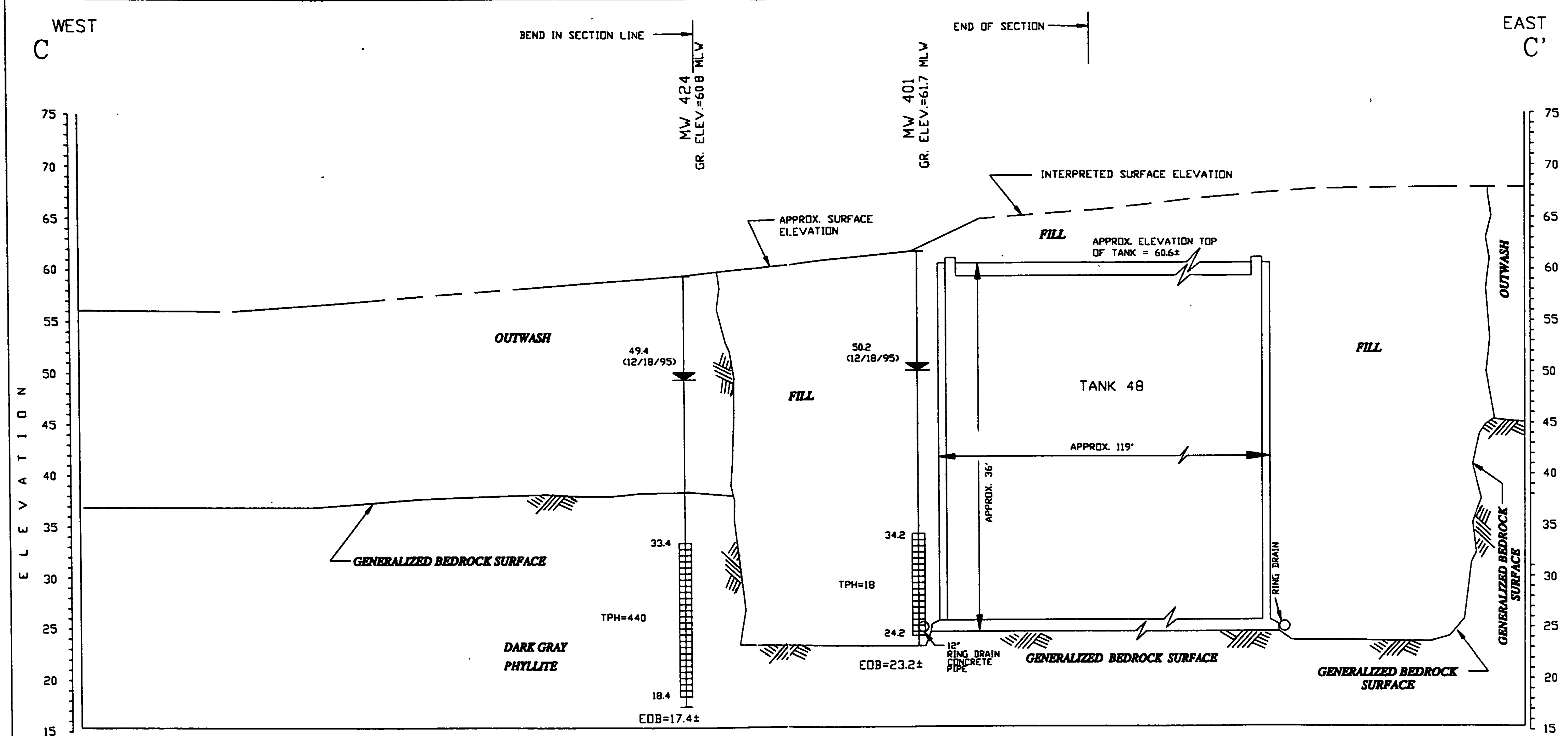
NOTE:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN NOT TO BE USED FOR DESIGN.

TPH IN GROUNDWATER

CROSS-SECTION B-B' - TANK 48				FIGURE 7-6
NETC-NEWPORT, RI				Brown & Root Environmental A Division of Halliburton NUS Corporation 55 Jonspin Road Wilmington, MA 01887 (508)658-7899
SITE INVESTIGATION REPORT - TANK FARM 4				
DRAWN BY:	R.G. DEWSNAP	REV.:	0	
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96	
SCALE:	1" = 10' (APPROX.)	FILE NO.:D:\DWG\NETC\SI-38-48\XSEC48BW		

W5296104F



LEGEND

46.9 / TPH=5.0 / 44.9	WELL SCREEN INTERVAL WITH ELEVATION AND GROUNDWATER TPH CONCENTRATION.
49.4 (12/18/95)	WATER TABLE ELEVATION IN FEET (MLW) (DATE OBSERVED)
TPH	TOTAL PETROLEUM HYDROCARBON (MG/KG)
MW 103	GROUNDWATER MONITORING WELL NUMBER
SB 205	SOIL BORING NUMBER
ND	NOT DETECTED
EOB	END OF BORING
GR. ELEV.	GROUND ELEVATION

GRAPHIC SCALE

10 0 10 20

Horizontal & Vertical Scale: 1IN. = 10 FT.

N O T E:

1) DEC. 1995, WATER LEVEL MEASUREMENTS REPORTED ON FIGURE.
2) ALL TPH UNITS IN MILLIGRAMS PER KILOGRAM (MG/KG).
3) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE.
4) PLAN <u>NOT</u> TO BE USED FOR DESIGN.

TPH IN GROUNDWATER

CROSS-SECTION C-C' - TANK 48			
NETC-NEWPORT, RI			
SITE INVESTIGATION REPORT - TANK FARM 4			
DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. HOLDEN	DATE:	23 FEB 96
SCALE:	1" = 10' (APPROX.)	FILE NO.: D:\DWG\NETC\SI-38-48\XSEC48CW	

FIGURE 7-7

Brown & Root Environmental
A Division of Halliburton NUS Corporation
55 Jonspin Road Wilmington, MA 01887
(508)658-7899

W5296104F

In summary, petroleum-impacted soils were noted in the bedrock socket from 15 feet bgs to the bottom of the socket at approximately 42 feet bgs. Lightly impacted soils were noted outside the socket from 22 to 23 feet bgs in soil boring 409, 40 feet downgradient of the tank. Petroleum-impacted soils extend 40 feet north of the tank in the former location of the tank construction access ramp at depths from 18 feet bgs to 26 feet bgs.

The TPH pattern identified by laboratory analyses of soils collected at Tank 48 during the PCA report was bunker oil. Personal communications have indicated that bunker oil and possibly No. 2 fuel oil were stored at Tank Farm 4 (Martin, 1995a). Most laboratory results indicated the presence of heavy oils in soil samples, including bunker oil. Mr. Henry Liebowitz (Ceimic) indicated that weathered bunker oil and No. 6 fuel oil often cannot be differentiated (Martin, 1995b).

7.3.2 Bedrock

Two bedrock wells, MW-424 and MW-425 were installed during the SI activities at Tank 48. SB-424/MW-424 is located approximately 27 feet west of Tank 48 on the hydraulically downgradient side of the tank. MW-425 is located approximately 65 feet northwest of Tank 48 on the downgradient side of the tank. MW-425 was advanced adjacent to SB-419, and no soil samples were collected.

MW-424 was advanced through the unconsolidated overburden using hollow-stem augers. The boring was advanced to the weathered bedrock surface at approximately 17 feet bgs. Standard interval soil samples were collected to refusal. The upper 5 feet of bedrock (21 to 26 feet bgs) was a very fissile, soft, and highly fractured grey to dark grey phyllite with numerous quartz and calcite veins. The Rock Quality Designation (RQD) of the first core run was calculated at 30 percent, which confirms the highly fractured nature of the upper bedrock (Appendix B). The bedrock became less fractured to the end of the boring at 42 feet bgs.

A petroleum sheen was observed in bedrock fractures in MW-424 from approximately 30 feet bgs to 41 feet bgs. NAPL was present in fractures and fracture surfaces in the interval from 41 to 42 feet bgs (the end of the boring) and were heavily stained with petroleum.

MW-425 was advanced with hollow-stem augers to refusal at 18 feet bgs. Coring was conducted from 22.5 feet to a depth of 42.5 feet bgs. The bedrock is a dark grey, highly fractured phyllite that contains 2 to 5 inch interbeds of schistose rock, as well as numerous quartz and calcite veins.

The first core run at MW-425 was heavily petroleum-impacted throughout. A heavy petroleum sheen and NAPL were noted in bedrock fractures from an interval from 21.5 to 42.5 feet bgs. The degree of petroleum impact lessened slightly with increased depth, until only a light sheen was noted in fractures at the end of the boring at 42.5 feet bgs.

7.3.3 Groundwater

A groundwater sample round was conducted in December 1995, as part of the SI. Nine wells were sampled at Tank 48, seven of which were screened at depths within petroleum-impacted soils.

Table 7-4 presents a comparison of TPH concentrations in groundwater to TPH concentrations in a corresponding 2-foot split-barrel soil sample interval. MW-424 and MW-425 were completed in bedrock, and the bedrock was not analyzed for TPH. Little correlation exists between TPH concentrations in soil and TPH concentrations in groundwater. Concentrations of TPH in groundwater range from below detection limits (MW-421) to 440 mg/L in bedrock well MW-424 (Figure 7-7).

Petroleum was seen on fracture planes at MW-424. MW-424 is approximately 27 feet away from the tank. The elevation of the screen interval, 18 to 33 feet mlw, intersects the approximate elevation of the bottom of the tank and the ring drain (25 feet mlw). At Tank 48, the bedrock aquifer may act as a potential pathway for petroleum-impacted groundwater.

The highest concentration of TPH in an overburden well, 87 mg/L, was detected in MW-404 (Figure 7-5). MW-404 is located within the ramp area of the tank, and may be a wide topographic low where petroleum has accumulated in soils. This is supported by a high concentration (4,600 mg/kg in SB-404) of TPH in soil. The concentration of TPH in the other overburden wells varies from below detection limits (MW-421) to 18 mg/L in MW-401 (Figure 7-6).

7.3.4 Hydraulic Conductivity Measurements

Hydraulic conductivity testing was conducted in seven wells at Tank 48: MW-119, MW-408, MW-409, MW-421, MW-422, MW-424, and MW-425. Additional testing was conducted at Tank 45 and Tank 50 (during the SI conducted at Tank 50, Tank Farm 5, B&R Environmental, 1995b), as described in Section 3.3.2.

Interpretation of the data indicates that in-situ soils have a hydraulic conductivity between 1.4E-03 and 9.5E-04 centimeters per second (cm/sec), while the fill surrounding the Tanks has a hydraulic conductivity between 6.66E-02 and 2.5E-03 cm/sec. The hydraulic conductivity of the bedrock was between 1.0E-03 and 1.2E-04 cm/sec (Table 3-1).

7.3.5 Saturated Thickness

The area of investigation is dominated by the presence of the large UST (36-feet high by 119-feet in diameter) and an excavation backfilled with material of widely varying porosity that extends approximately 14 feet below the original bedrock surface. The saturated thickness of the aquifer in the unconsolidated materials is therefore a function of the location of the tank socket.

Using December 1995 groundwater levels measured in MW-408, the depth to the water table is approximately 17.6 feet bgs. Based on an estimated socket depth of 44 feet, the saturated thickness of the aquifer within the socket is approximately 26.5 feet.

The depth to bedrock in SB-409, outside of the socket, is approximately 23.3 feet bgs. The water table is approximately 12.6 feet above the bedrock surface (Figure 7-6). The saturated thickness of the aquifer outside the socket at MW-409 is approximately 13 feet.

7.3.6 Surface Soil

Two surficial soil samples collected in an area overlying the tank were submitted for TPH analysis (Figure 7-1). The sampling objective was to evaluate the presence of petroleum-impacted soils overlying the roof of Tank 48. The sample locations were selected to evaluate soils in areas of the tank that would be impacted in the event of an overfill. Samples were collected at the tank man-way and vent. No overfills were documented at the tank.

Analytical results indicate TPH was detected at 54 mg/kg in sample SS-02, collected 2 to 6 feet in front of the tank man-way. The TPH concentration was below detection limits in sample SS-01, collected 2 to 6 feet beside the vent. Analytical results are presented in Table 7-6.

TABLE 7-6
TPH IN SURFACE SOIL
TANK 48, TANK FARM 4
SITE INVESTIGATION REPORT
NETC - NEWPORT, RHODE ISLAND

SAMPLE ID	DEPTH SAMPLED	CONCENTRATION (mg/kg)	EXCEEDS GUIDANCE OF 2,500 mg/kg (YES/NO)
TK48-SS-01	01-02	ND[1]	No
TK48-SS-02	01-02	54[1]	No

Legend:

mg/kg - milligram per Kilogram
ND - Not Detected
(1) - EPA Method 418.1

7.4 VOLATILE ORGANIC COMPOUND MONITORING

Preliminary Closure Assessment

PCA laboratory results indicate that VOCs are not significant components of petroleum-impacted soils or groundwater (Table 7-2). An on-site source of VOCs that would result in a release to the ambient air has not been identified.

Site Investigation

During the soil sampling task of the SI, samples were field screened with a FID to evaluate the presence of VOCs. Ambient air screening with a PID was also conducted as part of routine health and safety monitoring to protect site workers.

Results from both investigations indicate that no VOCs were detected in the ambient air or in soils at Tank 48.

7.5 SURFACE WATER AND SEDIMENT SAMPLING

Runoff from the area near Tank 48 drains through moderately developed drainage features into Normans Brook, located approximately 930 feet southwest of the tank. Most rainwater, however, infiltrates into soil and permeable fill materials and exits the site as groundwater.

TRC-reported results from surface water and sediment samples collected from Normans Brook and a swale upgradient from Normans Brook have shown indications of low concentrations of petroleum in both media (TRC, 1992). It is not clear however, if the source of petroleum in the brook is due to petroleum-impacted surface water runoff, the discharge of impacted groundwater from Tank 48, or the discharge of impacted groundwater from another source to the brook.

7.6 COMPARISONS TO REGULATORY STANDARDS

Laboratory analytical results were evaluated with respect to one or more of the following regulatory standards:

- Rhode Island Department of Health Lead Poisoning Prevention Standard (150 mg/kg) (RIDOH, 1992).

- U.S. EPA "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities" (400 ppm) (EPA, 1994a).

- U.S. EPA "Drinking Water Regulations and Health Advisories" (Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs)) (EPA, 1994b).

- RIDEM "Rules and Regulations for Groundwater Quality" (Groundwater Quality Standards and Preventative Action Limits) (RIDEM, 1993b).

- "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA Groundwater Protection Standard) (EPA, 1991).

Regulatory standards have not been established for benzene or any of the detected semi-volatile organic compounds in soil. Similarly, no standards have been established for arsenic, barium, cadmium, and chromium in soil.

The Rhode Island Department of Health "lead-free" standard (1992) for soil was used to evaluate lead in subsurface soil samples B482729 and B483941. This standard, 150 mg/kg, is designed to protect children in residential settings. The U.S. EPA guidance (1994a) for CERCLA Sites and RCRA Corrective Action Facilities was also used to evaluate the detected lead result. This directive recommends a 400 mg/kg screening level for lead in soil designated for residential land use.

The B482729 and B483941 soil lead concentrations (9.0 mg/kg and 6.1 mg/kg) do not exceed either of these standards.

Mercury detected in the MW-119 groundwater sample was evaluated with respect to MCLs and the RIDEM groundwater standard (RIDEM, 1993; U.S. EPA, 1994b). The federal and State of Rhode Island regulatory standard for mercury in groundwater is 2 μg/L. In the MW-119 groundwater sample, mercury was detected at a concentration of 0.42 μg/L. This concentration does not exceed either of the standards.

Mercury detected in the MW-119 groundwater sample was also compared to the RCRA groundwater protection standard (U.S. EPA, 1991). This standard, 2 μg/L, is designed to ensure that hazardous constituents detected in the groundwater from a regulated unit do not exceed specified concentration limits. The mercury concentration does not exceed the RCRA groundwater protection standard.

7.6.1 TPH Clean-up Levels

TPH clean-up levels are identified to develop remedies to protect human health and the environment and to ensure that the selected remedial alternative will properly address concerns at the site. Two objectives were considered in developing clean-up levels at Tank Farm 4 and these levels will be used to select appropriate future actions at the tank farm. The objectives are:

- Protect human health from risks on site associated with ingestion of, inhalation of, and dermal contact with impacted soils

- Protect human health and the environment by controlling any off-site migration of contaminated groundwater

RIDEM has established guidance concentrations of TPH in soils that specifically apply to using excavated soil as backfill material following a UST removal. RIDEM generally establishes UST-related soil and groundwater clean-up criteria on a case-by-case basis considering potential off-site migration of impacted groundwater, and the presence of site-specific potential human and ecological receptors.

7.6.1.1 Exposure Routes

A significant objective of a clean-up level is to minimize the effects of chemicals to human and environmental receptors. Potential exposure routes of impacted soils to humans include ingestion, dermal contact, and inhalation of fugitive dust from surface soils. Because most impacted soils are located beneath a minimum of 10 feet of "unimpacted" soils, these exposure pathways do not present a significant risk to humans at the site surface.

Several exposure pathways that have been identified through pathway modeling (B&R Environmental, 1996) include: dermal contact of impacted soils by a construction worker who may be exposed during excavation activities or ingestion of small quantities of soil by workers or trespassers.

Potential inhalation of VOCs is not considered an exposure pathway at the site. No VOCs were detected in ambient air during health and safety monitoring conducted during site investigation field work. Sampling and analysis of soils during the PCA confirmed the presence of only very low concentrations of VOCs in impacted site soils and groundwater.

Ingestion of groundwater is not considered a potential exposure pathway because local groundwater resources are classified as a type "GB" aquifer (Code of Rhode Island Rules Number 12-100-006, Section 9 and Appendix II), which is not suitable for drinking. Also, Tank Farm 4 is not located within a groundwater reservoir or groundwater recharge area (Code of Rhode Island Rules Number 12-100-006, Appendix III and IV) and no public or private water supply wells are located downgradient of the tank farm. The only potential pathway of human exposure to petroleum-impacted groundwater is through dermal contact at areas of groundwater discharge to surface water bodies.

Tank 48 is on the southwestern side of the tank farm, approximately 930 feet upgradient from Normans Brook. Although most runoff infiltrates into soil and permeable fill materials and exits the site as groundwater, a portion of the runoff from Tank 48 may drain southwesterly through moderately developed surface water drainage features into Normans Brook. TRC-reported results from surface water and sediment samples collected from Normans Brook and a swale upgradient from Norman's Brook have shown indications of low concentrations of petroleum in both media (TRC, 1992). It is not clear, however, if the source of petroleum in Norman's Brook is due to petroleum-impacted surface water runoff, or to the discharge of impacted groundwater to the brook.

7.6.1.2 Proposed Clean-up Levels

RIDEM has a policy of establishing site-specific TPH clean-up levels. TPH concentrations in soil of 2,500 mg/kg and 5,000 mg/kg will be proposed by the Navy as clean-up levels at Tank 48. These concentrations are considered conservative and were adopted as soil clean-up standards by Massachusetts and published as part of the MCP in November, 1993 (MADEP, 1996) and are not legally binding in Rhode Island.

These soil standards were established based on the characterization of risk posed by petroleum-impacted disposal sites. The MCP and various guidance and policy documents issued by the MADEP describe the documentation of site risk. Both groundwater usage (310 CMR 40.0931 and 40.0932) and accessibility to soil (310 CMR 40.0931 and 40.0933) are considered in the site risk characterization.

The proposed clean-up level of 2,500 mg/kg TPH in soil considers that soils may be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(b)), and are "potentially accessible," described as being "located at a depth of 3 - 15 feet below the surface..." (310 CMR 40.0933(4)(c)).

The proposed clean-up level of 5,000 mg/kg TPH in soil considers that soils may also be located within the zone of contribution of a water supply well (310 CMR 40.0932(4) and 40.0975(6)(a)), and are "isolated," described as being "located at a depth greater than 15 feet below the surface..." (310 CMR 40.0933(4)(c)). The applicable sections of the MCP are included in Appendix E.

7.7 FUTURE ACTIONS

The following section presents recommended future actions at Tank 48. Two actions are discussed: source control, and interim action.

7.7.1 Source Control

Tank contents removal and cleaning is scheduled for the summer of 1996. Product will be removed from the tank and the tank will be cleaned and closed. The tank will be inspected and closed following approval by RIDEM.

7.7.2 Interim Action

Groundwater levels are lowered to the elevation of the tank bottom during tank closure operations. The ring drain system is used to manage the groundwater level at the tank for the duration of closure activities, a period of approximately one to two months. During the pumping operations, some NAPL may be removed from the impacted fill materials in the tank socket in conjunction with groundwater withdrawal. This pumping action may result in removing contaminant mass from the system, thereby lowering petroleum concentrations at the site.

Following the interim action, additional groundwater and subsurface soil samples will be collected from zones of petroleum-impacted soil that were identified during the SI as exceeding proposed clean-up standards. Samples will be analyzed by Method 418.1, and compared to results of analyses conducted during the SI. Also, several groundwater samples should be collected from wells screened in both the unconsolidated overburden and bedrock aquifers, and analyzed by Method 8015 to obtain a petroleum fingerprint to fully characterize the petroleum.

The need for additional remedial action will be evaluated based on results of the interim action.

8.0 SUMMARY AND CONCLUSIONS

8.1 GENERAL

The SIs described in this report were scoped to provide data at Tanks 38, 42, 45, and 48 to delineate the extent of petroleum-impacted soils and groundwater, identify threats to public health and the environment, and provide data to develop response objectives at each tank. The data presented in this report meet these objectives; however, contingent on the selection of a site remedy, additional data may be necessary to further define parameters required to implement the selected alternatives.

Based on an evaluation of the data discussed in this report, petroleum releases, identified as heavy fuel oil and possibly diesel fuel, are likely to have occurred at Tanks 38, 42, 45, and 48. Results of structural integrity inspections conducted during closure activities at Tank 42 and Tank Farm 5 indicate that leaks of fuel oil from the tanks may have occurred through cracks on the tank floor and possibly from cracks in the lower portions of tank walls. Petroleum-impacted soils are located at depth adjacent to each tank, and residual NAPL is present in fill materials within the tank sockets.

Tank 42 has been emptied and the tank interior was cleaned. Tank 42 has also been ballasted with clean water to the approximate water table level in order to minimize the possibility of further cracking of the tank floor by differential buoyant forces. Ballasting the tanks to the approximate level of the water table minimizes the differential hydrostatic pressure inside the tank with the groundwater head, thus minimizing the potential for water to migrate from the tank as a result of future minor tank failure. The tank has passed both the Navy structural integrity inspection and a RIDEM post-closure inspection for completeness of cleaning.

Tanks 38, 45, and 48 are scheduled for cleaning in summer 1996.

8.2 TANK 38

Petroleum-impacted soils were identified within the Tank 38 socket below 30 feet bgs in the three borings located within the tank socket. Low to moderate concentrations of petroleum were detected in these soils, ranging from 130 mg/kg up to 2,100 mg/kg.

Petroleum-impacted soil samples containing NAPL were observed during the PCA within the Tank 38 socket. However, results of laboratory analysis indicated TPH concentrations were below detection limits. Heavy staining and the occurrence of residual NAPL were noted during advancement of borehole B-38 at a depth of 32 to 34 feet bgs, and again at 39 feet bgs. Petroleum-impacted soils were also noted in the three borings advanced as part of the SI at depths below 30 feet bgs.

Soil boring SB-415 was advanced approximately 25 feet downgradient of the tank, outside of the tank socket, and did not encounter petroleum-impacted soils. This indicates that petroleum is not migrating through the overburden outside the tank socket.

TPH was detected at low concentrations in two surface soil samples collected at Tank 38; neither sample exceeded the proposed clean-up guidance level.

Immiscible oil droplets and a light sheen were noted in groundwater during well development and groundwater sampling in MW-125. The maximum concentration of TPH in groundwater was 24 mg/L in MW-417, which is screened in the ring drain. A light petroleum sheen and immiscible oil droplets were observed in groundwater during well development and groundwater sampling conducted in MW-416, MW-417, and MW-418.

No soil samples exceeded the TPH-in-soil clean-up criteria proposed by the Navy.

8.3 TANK 42

Petroleum-impacted soils were located within the socket of Tank 42 from a depth of 30 feet bgs, to the bedrock surface, approximately 40 feet bgs. Impacted soils were identified at that depth in borings SB-407, and SB-411, with a maximum TPH concentration of 5,700 mg/kg from 36 to 38 feet bgs in boring B-42, installed as part of the PCA. The maximum thickness of impacted soils (approximately 11 feet) was located in the vicinity of MW-411, in the tank socket upgradient of the tank. At this boring, impacted soils were first identified at 30 feet bgs. Impacted soils thinned toward the downgradient side of the tank, and were not detected in boring SB-413. Petroleum-impacted soils were noted primarily below the water table. Residual NAPL was noted throughout the impacted soils, typically saturating coarse-grained soils. Petroleum also occurred as coatings on sand- and gravel-size particles in coarser grained soils. A heavy sheen was present on soil samples collected from below the water table.

TPH was not detected in boring SB-410, located approximately 27 feet downgradient from Tank 42, outside the socket. This indicates that petroleum is not migrating through the overburden outside the tank socket.

Two surface soil samples were collected from the area near the man-way and the tank vent. The analytical results from both samples were below laboratory detection limits for TPH.

The TPH concentration in groundwater was below laboratory detection limits in the sample collected from MW-413. Groundwater samples collected from the other wells screened within the tank socket have a maximum TPH concentration of 10 mg/L. A petroleum sheen and immiscible oil drops were noted during well development of MW-123, MW-407, and MW-411.

Results of the structural inspection indicated that minor cracks were present on the tank floor and lower tank walls. Stone and Webster reported that the cracks noted in the tank did not require repair (Appendix A).

One soil sample collected at Tank 42 exceeded the TPH-in-soil clean-up criteria proposed by the Navy.

8.4 TANK 45

Petroleum-impacted soils were located within the Tank 45 socket. Impacted soils were identified from a depth of 26 feet bgs, to the bedrock surface, approximately 40 feet bgs. The maximum thickness of impacted soils (12.7 feet) was located in the vicinity of SB-331, located in the tank socket, upgradient of the tank. The maximum TPH concentration in soil at Tank 45 was 23,000 mg/kg and was collected in SB-330 from fill material located 38 to 40 feet bgs. TPH was also detected in soils from similar or deeper intervals surrounding the tank, such as 1,000 mg/kg detected from 34 to 36 feet bgs in B-45. The presence of TPH compounds was noted primarily below the water table, except at SB-335, where the TPH concentration was 7,100 mg/kg 3 to 5 feet above the water table. The presence of petroleum here may be the result of smearing at the seasonal groundwater high. Residual NAPL was noted throughout the impacted soils, typically in coarse-grained soils. Petroleum also occurred as coatings on sand- and gravel-size particles in coarser grained soils. Soil borings SB-333, SB-334, and SB-336 were advanced up to 36 feet downgradient of the tank, outside of the tank socket, and did not encounter petroleum-impacted soils. This indicates that petroleum is not migrating through the overburden outside the tank socket.

Two surface soil samples were collected from the area near the man-way and the tank vent. The analytical results from both samples were below laboratory detection limits for TPH.

Groundwater samples collected from four wells screened within petroleum-impacted soils have a maximum TPH concentration of 9.3 mg/L. A light petroleum odor and sheen on groundwater were noted during the development and sampling of MW-330 and MW-331.

Three soil samples collected at the tank exceeded the TPH-in-soil clean-up criteria proposed by the Navy.

8.5 TANK 48

Petroleum-impacted soils were located within the Tank 48 socket. Boring B-45 (MW-119) indicated the presence of TPH-impacted soils (maximum concentration of 5,300 mg/kg), within the socket at the downgradient edge of the tank. TPH impacted soils were noted approximately 27 feet bgs to the end of the boring, approximately 40 feet below ground surface, interpreted to be the bedrock surface. Results of investigations conducted during the SI indicated that soils throughout the tank socket were heavily impacted with NAPL that saturated coarse grained fill materials.

MW-422 was advanced approximately 40 feet from the tank in the upgradient direction, and in the tank construction access ramp. A slight oil sheen was noted at 14 feet bgs in MW-422, and soils containing NAPL and heavy petroleum coatings were noted from 18 feet bgs to refusal at approximately 26 feet bgs.

The presence of TPH compounds was noted primarily below the water table at Tank 48. Residual NAPL was noted throughout the impacted soils, typically saturating coarse-grained soils. Petroleum also occurred as residual coatings on sand- and gravel-size particles in coarser grained soils.

Soil borings SB-414, SB-419, SB-420, and SB-421, were advanced between 30 and 75 feet downgradient of the tank, outside the tank socket, and did not encounter petroleum-impacted soils. This indicates that petroleum is migrating through the overburden only a short distance from the tank socket.

Borings SB-424 and SB-425 were completed as bedrock monitoring wells (MW-424 and MW-425) to determine if TPH was migrating in the bedrock away from the socket. The first indication of petroleum impact at MW-424 was at approximately 30 feet bgs: a light petroleum sheen and small amount of residual oil was noted in the fractures. Similar petroleum impact was noted in bedrock fracture zones from 31 to 41 feet bgs. In the interval from 41 to 42 feet bgs, petroleum impact was found to consist of NAPL and oil coatings in fractures. The first core run at MW-425 was heavily petroleum impacted throughout. A heavy petroleum sheen and NAPL were noted in fractures. Petroleum impact was noted in fractures and fracture zones at 21.5 to 42.5 feet bgs. The degree of petroleum impact lessened slightly with increased depth, until only a light sheen was noted in fractures at the end of the boring at 42.5 feet bgs.

Two surface soil samples were collected from the area near the man-way and the tank vent. The analytical results from sample TK48-SS-01 were below laboratory detection limits for TPH. The analytical result for sample TK48-SS-02, located approximately 5 feet from the man-way door, was 54 mg/kg of TPH. This result does not exceed the recommended guidance level.

TPH concentrations were below the laboratory detection limit of 1 mg/L in groundwater samples collected from monitoring well MW-421, and bedrock monitoring well MW-425. The maximum aqueous TPH concentration at Tank 48 was 440 mg/L from bedrock well MW-424. At Tank 48, it appears the bedrock aquifer may act as a potential pathway for migration of petroleum-impacted groundwater. A petroleum sheen and immiscible drops were noted during the development and sampling of MW-119, MW-401, MW-404, MW-408, MW-409, MW-412, MW-422, MW-424, and MW-425.

The soil sample collected from 27 to 29 feet bgs in boring B-48 exceeded the TPH-in-soil clean-up criteria proposed by the Navy.

8.6 GROUNDWATER

The presence of only low concentrations of TPH in groundwater samples collected from monitoring wells installed downgradient of the tanks indicates that the unconsolidated overburden aquifer is not a significant migration pathway for heavy fuel oil compounds released from the tanks. Individual petroleum compounds identified in groundwater at the tanks were present at concentrations significantly lower than their water solubilities. Interpretation of these data suggests that dissolution of the residual free-phase petroleum into groundwater is minimal, possibly a result of a limited contact area of residual NAPL with groundwater.

A groundwater sample collected from well MW-421, located approximately 70 feet hydraulically downgradient of Tank 48, outside of TPH-impacted soils, has a TPH concentration below the detection limit. This also supports the conclusion that the overburden aquifer is not a significant migration pathway for petroleum compounds released from the tanks at Tank Farm 4.

Petroleum was not observed in soil samples collected from borings advanced outside of the socket, downgradient of Tanks 38, 42, or 45. Petroleum-impacted subsurface soils were observed approximately 50 feet downgradient of Tank 48. This supports a conclusion that TPH is not migrating in groundwater through the unconsolidated overburden aquifer.

TPH was detected in the groundwater sample collected from bedrock well MW-424 at a concentration of 440 mg/L at Tank 48. Analytical results from the groundwater sample for the second bedrock well, MW-425, was below laboratory detection limits. Both wells were screened in the upper 20 feet of the bedrock. The bedrock may, at this location, act as a migration pathway for impacted groundwater. However, the full extent of petroleum-impacted groundwater has not been delineated at this location.

8.7 VOC MONITORING

Air monitoring and soil screening with a PID at each tank indicated that no VOCs were detected in the ambient air or in soils at the tanks.

8.8 WELLHEAD PROTECTION INFORMATION

The tanks are not located within a designated wellhead protection area. The groundwater beneath the tanks is classified by RIDEM as "GB". Groundwater classified as GB is not suitable for public or private drinking water use.

8.9 POTENTIAL RECEPTORS

No private or public potable water supply wells are located on, or downgradient from, the tanks. No known private wells or basements exist that could potentially be affected by the petroleum releases.

9.0 RECOMMENDATIONS

9.1 TANKS 42, 45, AND 48

The following section presents recommendations for Tanks 42, 45, and 48. Two actions are discussed: source control and interim action.

9.1.1 Source Control

Source control consists of removing tank contents and cleaning. These tasks are scheduled at Tanks 45 and 48 during the summer of 1996. Product will be removed from the tanks and the tanks will be cleaned. The tanks will be inspected and closed following approval by RIDEM.

The contents of Tank 42 were removed and the tank was closed in December 1995, thus completing the source control task at this tank.

9.1.2 Interim Action

Groundwater levels are lowered to the elevation of the tank floor during tank closure operations. The ring drain system is used to manage the groundwater level at the tanks for the duration of closure activities, a period of approximately one to two months. During the pumping of ring drains for tank closure activities at Tank Farm 5, an undetermined quantity of petroleum was removed from fill materials within the socket and treated in the on site water treatment facility. Although data is not available to quantify the removal of petroleum mass from the fill materials, TPH concentrations detected in samples collected during the SI (conducted after ring drain pumping) were consistently lower than TPH concentrations in samples collected during the PCA (conducted prior to ring drain pumping). The pumping action may have resulted in the removal of enough contaminant mass from the fill materials surrounding each tank to lower petroleum concentrations at the sites.

Following the interim action, additional groundwater and subsurface soil samples will be collected from zones of petroleum-impacted soil identified during the SI as exceeding proposed clean-up standards. Samples will be analyzed by Method 418.1 and compared to results of analyses conducted during the SI. Investigations at Tank 42 were conducted prior to the completion of ring drain pumping activities; therefore, soils and groundwater at Tank 42 should also be resampled.

A work plan addendum will be prepared concurrent with the interim action. The addendum will describe additional investigations to follow the interim action and will be submitted for approval by RIDEM.

The need for additional remedial action will be evaluated based on results of the additional sampling after completion of the interim action, and on results of the bioremediation pilot test at Tank 50.

9.2 TANK 38

The following section presents recommendations for further actions at Tank 38.

9.2.1 Source Control

Source control consists of removing tank contents and cleaning. These tasks are scheduled for Tank 38 during the summer of 1996. Product will be removed from the tank and the tank will be cleaned. The tank will be inspected and closed following approval by RIDEM.

9.2.2 Development of Remedial Alternatives

The next phase of the project includes developing the proposed Institutional Control alternative, which will identify specific actions required to provide effective control at Tank 38. The alternative should protect potential human and ecological receptors, and meet the proposed soil clean-up levels of 2,500 mg/kg TPH in soils at depths of 3 to 15 feet and 5,000 mg/kg TPH in soils at depths of 15 feet or more.

Deed restrictions are institutional controls that are placed on property deeds. These restrictions are proposed to limit future activities or uses of a site to prevent human contact with, in the case of Tank Farm 4, petroleum-impacted soil or groundwater. Deed restrictions commonly used to reduce exposure to impacted media include prohibitions on installing water supply wells, restrictions on types of development allowed, i.e., no residential use, and limitations on certain types of construction, i.e., excavation for buildings with basements.

Site access restrictions may be used to limit access to areas where hazards to humans may occur, such as tank man-ways and steel plates covering construction access holes cut in the tank tops. Warning signs should be posted at Tank 38 alerting site workers and trespassers of the hazards of unauthorized entry into secured tank man-ways. The hazards of driving vehicles across tank tops should also be stated on the warning signs. Construction access ports in the tank tops have been covered with 2 to 3 feet of topsoil and secured with steel plates that may not be sufficiently strong to support the weight of vehicular traffic. Groundwater monitoring should consist of annual sampling of one groundwater monitoring well screened in the unconsolidated overburden outside of the tank socket, located approximately 25 feet downgradient of the tank.

Based on the use of the tank as storage for virgin petroleum, sample analyses should be conducted for TPH using EPA Method 418.1. Petroleum product was assumed to be released to the environment over a period of many years during the operational history of the tank farm; however, as indicated in this site investigation, product has not migrated out of the tank socket. In light of this finding, monitoring will be conducted for a three-year period to confirm that ambient conditions have not changed. Source control, consisting of tank contents removal, tank cleaning, and repair of open cracks on the tank floors and walls has eliminated continued release of petroleum to the environment.

A health and safety plan should be prepared to address specific hazards posed by subsurface petroleum-impacted soils to construction personnel engaged in excavation or other surface maintenance and construction activities. The plan should address procedures taken by construction personnel to address fugitive dust emissions management and other site safety precautions such as the use of personal protection equipment (PPE).

9.2.3 Additional Investigation

The need for additional site characterization will be continually monitored throughout the development of the remedial alternative phase.

9.2.4 Preparation of the Corrective Action Plan

RIDEM regulation DEM-DWM-UST05-93 Sec. 14.11 establishes the requirements for the preparation of a Corrective Action Plan (CAP) to formalize the approved alternative. Upon RIDEM approval of this report, a CAP will be prepared for Tank 38 which includes specific actions to be implemented under Institutional Controls.

REFERENCES

REFERENCES

B&R Environmental (Brown and Root Environmental). 1996. "Technology Screening Evaluation Report Tank 50, Tank Farm 5", NETC-Newport, Rhode Island. January, 1996.

B&R Environmental (Brown and Root Environmental). 1995a. "Draft Tank 42 Closure Assessment Report, Tank Farm 4", NETC-Newport, Rhode Island. December.

B&R Environmental (Brown and Root Environmental). 1995b. "Site Investigation Report Tank 50, Tank Farm 5", NETC-Newport, Rhode Island. December, 1995.

Bouwer, Herman, and R. C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3, June 1979.

Dragun, J. 1988. The Soil Chemistry of Hazardous Materials. Maryland: Hazardous Materials Control Research Institute, pp. 398-411.

EPA (U.S. Environmental Protection Agency). 1991. "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." 40 Federal Register 264, Subpart F, pp. 169-170, July 1.

EPA (U.S. Environmental Protection Agency). 1994a. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities", Office of Solid Waste and Emergency Response, Directive 9355.4-12.

EPA (U.S. Environmental Protection Agency). 1994b. "Drinking Water Regulations and Health Advisories", EPA 822-R-94-001. May.

Federici and Associates. 1996. Plan Showing Location of Monitoring Wells at Tank Farm 4, NETC-Newport, Rhode Island. January.

Hermes, O.D., L. P. Gromet, D. P. Murray, and N. A. Hamidzada. 1994. Bedrock Geologic Map of Rhode Island. Rhode Island Map Series No. 1. Published by: Office of the Rhode Island State Geologist.

HNUS (Halliburton NUS Corporation). 1994. "Work Plan, Preliminary Closure Assessments of Tank Farms 4 and 5", NETC-Newport, Rhode Island. September.

HNUS (Halliburton NUS Corporation). 1995a. "Preliminary Closure Assessment Report of Tank Farms 4 and 5", NETC-Newport, Rhode Island. June.

HNUS (Halliburton NUS Corporation). 1995b. "Release Characterization Report for Tanks 38, 42, 45, and 48", NETC-Newport, Rhode Island. June.

HNUS (Halliburton NUS Corporation). 1995c. "Work Plan, Addendum 1, Site Investigation, Tank 50, Tank Farm 5, NETC-Newport, Rhode Island. March.

HNUS (Halliburton NUS Corporation). 1995d. "Results of Tank Gauging at Tank Farm 4", NETC-Newport, Rhode Island. March.

HNUS (Halliburton NUS Corporation). 1995e. "Work Plan, Addendum 2, Site Investigation, Tanks 38, 42, 45, 48, 51, 52, 54, and 47 at Tank Farms 4 & 5, NETC-Newport, Rhode Island. August.

Howard, P.H. 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume 1. Michigan: Lewis Publishers, Inc., pp. 279-258.

IES, 1993, Revised 1994, "Underground Storage Tank Closure & Cleanup Requirements", for the New England States, Volume I. Prepared for the U.S. Army Corps of Engineers.

Jalkut, K. E. (Brown & Root Environmental) 1995a. Verbal communication between Kayleen Jalkut (B&R Environmental) and J. Quinlan (Engineering Aide, Newport Water Department), RE: Areas in vicinity of Tank Farm 4 and Tank Farm 5 served by Newport Water Department. April 1.

Jalkut, K. E. (Halliburton NUS Corporation). 1995b. Telephone conversation between Kayleen Jalkut (HNUS) and Mike Snyder (HNUS, NETC-Newport, RI), RE: Depth below ground surface of the shunt and loop piping, Tank Farm 5, CTO 143. July 18, 1605 hrs.

Kruseman, G. P., and N.M. de Ridder, 1989, Analysis and Evaluation of Pumping Test Data, International Institute for Land Reclamation and Improvement, Wageningen, Netherlands.

MADEP, 1995. The Massachusetts Contingency Plan, 310 CMR 40.000, Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup, January , 1995.

Maguire and Associates. 1944. Technical Report and Project History - Contract No. Y-5586, "Underground Storage of Liquid Fuel Along Waterfront South of Naval NET and Fuel Depot, Melville, RI", January 19.

Maguire & Associates. 1956. Report on Advance Planning for FY 1958 - Contract No. NBy 195, "Reduction of Hydrostatic Pressure On Underground Petroleum Tanks At U.S. Naval Supply Depot - Fuel Facility Newport, RI", August 1956.

Martin, W. J. (Halliburton NUS Corporation). 1995a. Telephone conversation between Walter Martin (HNUS) and Bób Martin (DFSP, NETC-Newport, RI), RE: Tank Guaging and Utility Depths, Tank Farm 4, CTO 143. February 3, 0850 hrs.

Martin, W. (Halliburton NUS Corporation). 1995b. Telephone conversation between Walter Martin (HNUS) and H. Liebowitz (Ceimic Laboratories), RE: Analytical identification of various fuel oils, CTO 143. July 24.

Morrison, R.T. and Boyd, R.N. 1983. Organic Chemistry, Fourth Edition. Boston: Allyn and Bacon, Inc. pp. 1231-32; 1267-1272.

Puls, R. W. and Powell, R. M. 1992. "Acquisition of Representative Ground Water Quality Samples for Metals." Focus, pp. 167-176.

RIDEM (Rhode Island Department of Environmental Management). 1993a. "Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials". Regulation DEM-DWM-UST05-93.

RIDEM (Rhode Island Department of Environmental Management). 1993b. "Rules and Regulations for Groundwater Quality", Rule No. 12-100-006. July.

RIDOH (Rhode Island Department of Health). 1992. "Rules and Regulations for Lead Poisoning Prevention, [R23-24.6-PB]". February.

Sax, N.I. and Lewis, R.J. 1987. Hawley's Condensed Chemical Dictionary, Eleventh Edition. New York: Van Nostrand Reinhold Co., p. 428.

Shreve, R.N. and Brink, J.A. 1977. Chemical Process Industries, Fourth Edition. New York: McGraw-Hill Book Co., pp. 65-80.

Sittig, M. 1981. Handbook of Toxic and Hazardous Chemicals. New Jersey: Noyes Publications, pp. 562-565.

Town of Middletown. 1958. Plate Nos. 101, 104, and 105. Prepared by Vernon Graphics, Inc. Mt. Vernon, NY. July. (Plate No. 105 Revised, February 1994).

TRC (TRC Environmental Corporation). 1992. "Final Remedial Investigation, NETC-Newport, Rhode Island". January.

TRC (TRC Environmental Corporation). 1994. "UST Closure Plan and Conceptual Design, Tank Farm 5, NETC-Newport, Rhode Island. November.

USGS. 1975. Prudence Island Quadrangle, Rhode Island. U.S. Geological Survey, 7.5' Series (Topographic). 1955, photorevised in 1970 and 1975.

van der Kamp, G. 1976. Determining Aquifer Transmissivity by means of Well Response Tests: The Underdamped Case, Water Resources Research, Vol 12, No. 1, p.g 71-77.